

## NASA Science Mission Directorate - Applied Sciences Program

### *Agricultural Efficiency – Fiscal Year 2005 Annual Report \**



#### **SUMMARY**

The Agricultural Efficiency program element, through the NASA partnership with the USDA Foreign Agricultural Service (FAS), achieved significant accomplishments in 2005. The program completed a benchmark report documenting the improvements from NASA Earth science research to the FAS PECAD/CADRE (Production Estimates and Crop Assessment Division / Crop Condition Data Retrieval and Evaluation) decision support tool and initiated the operational transfer of the lake and reservoir height capability (benchmarked in 2004) from NASA to FAS. The Agricultural Efficiency team also completed a verification and validation report for the MODIS products delivered to FAS.

The benchmark report on PECAD/CADRE included application of a unique tool – Defect Detection and Prevention (DDP) – to quantify the reduction in risk in FAS crop production and yield estimates with the addition of NASA Earth observations data products (MODIS vegetation condition, crop area, etc.) and model results. The collaboration between NASA and USDA includes major contributions from NASA Centers (Goddard, Jet Propulsion Laboratory, and Stennis) and the Universities of Arizona, Maryland and Missouri. The collaboration will continue in 2006, and the program expects to achieve a major milestone with the benchmark report for the precipitation and soil moisture products.

The Agricultural Efficiency program element expanded its scope in 2005 with the selection of projects that will extend further the reservoir and lake monitoring activity and focus more explicitly on soil moisture products from AMSR-E data and other sources. These projects will enhance the FAS decision support tools. In FY05, the program will also support an exploratory project led by the Goddard Institute of Space Studies (GISS) extending NASA global climate models (GCM) to enhance U.S. Agency for International Development (USAID) decision tools to predict within-season growing conditions in Central and South America.

#### **MAJOR ACCOMPLISHMENTS**

##### ***Integrating NASA Earth Science Data into Global Agricultural Decision Support Systems***

In FY05, the project team completed fieldwork in Oklahoma and Argentina for verification and validation of a climate-based crop yield model. The project team also developed and evaluated products for precipitation and MODIS surface reflectance, completed a preliminary version of a Web portal and Agricultural Information System (AIS), adapted the project to take advantage of evolving technology, and began integrating the NASA products into FAS and the United Nations World Food Program (UN/WFP).

In FY06, the project team expects to complete a benchmark report on the impact of the climate-based crop model on FAS decision support tools. FAS plans to complete an operational AIS, incorporating precipitation and MODIS data, to provide a reusable system adaptable for other USDA agencies. The team will develop a Web portal to make project results available to a wide audience.

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\* The FY05-09 Agricultural Efficiency Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

### ***Integrating NASA Models and Missions into Climate and Agriculture Decision Support Tools***

This project began in FY05, and the project team configured and ran current climate simulations using GISS GCM ocean temperature data. The team defined statistical relationships of climate teleconnections, such as El Niño/Southern Oscillation (ENSO), the North Atlantic Oscillation (NAO), Arctic Oscillation, and the Pacific/North American (PNA) pattern. The project team ran climate change scenarios with the GISS GCM and projected how ENSO interactions may change with climate change. The project team also worked with USAID to develop a week-long scoping mission, established extensive in-country contacts, and set up a baseline evaluation of relevant regional agricultural decisions.

In FY06, the project team will conduct a scoping mission to Uruguay and Central America to strengthen connections with the decision support system users and to better understand the data and database needs of the user groups.

### ***Support of Application of NASA EOS MODIS Data by USDA Foreign Agricultural Service***

In FY05, the project team expanded global coverage of near real time MODIS Rapid Response (RR) data; prototyped a RR Vegetation Index (VI) composite product; developed a global, flexible, interactive crop-likelihood mask and a vegetation moisture stress index; enhanced the database management system to improve system response time, robustness, and usability; developed a calibrated NOAA-AVHRR vegetation index; and, prototyped a 7-2-1 band combination of 16-day MODIS composite data to enhance Database Management System (DBMS) analysis capabilities.

In FY06, the project team will develop the rolling VI composites to enable more frequent and timely delivery of VI to FAS. The project team will also design and begin to implement the FAS production system at NASA-Goddard, and it will test and validate the flexible crop mask and vegetation moisture stress index developed in FY05.

## **SOLICITATIONS**

### ***Decisions CAN***

The Agricultural Efficiency program element received 33 Step-1 proposals in the Decisions CAN and encouraged 22 to submit full proposals. In Step-2, the Agricultural Efficiency program element received 23 full proposals. Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected the following Agricultural Efficiency proposals for awards:

Integrating MODIS and VIIRS NPP Observations into the USDA FAS Decision System

*PI: Christopher Justice, University of Maryland–College Park*

Integrate NASA's Global Soil Moisture Remote Sensing and Modeling Data into USDA's Global Crop Production Decision Support System

*PI: Xiwu Zhan, University of Maryland–Baltimore County (since moved to USDA)*

The program selected the following proposals for a single, combined project serving the Agricultural Efficiency, Public Health, and Disaster Management program elements:

Integrating NASA Earth Science Results into Malaria Early Warning Products to Enhance USAID Food Security and Disaster Management Decision Making

*PI: James Verdin, USGS EROS Data Center*

Enhancing the Famine Early Warning System Network Decision Support System with NASA Earth System Science Data and Modeling Results

*PI: Molly Elizabeth Brown, NASA Goddard Space Flight Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including two projects for the Agricultural Efficiency portfolio:

Enhancement and Expansion of the Near-Real Time Lake and Reservoir Monitoring System

*PI: Charon Birkett, NASA Goddard*

Improving the RUSLE Model Using Remotely Sensed Crop Residue Maps

*PI: Susan White, Institute for Technology Development*

### **ROSES 2005 – Section A.24**

For the Applied Sciences portion of the ROSES 2005 NRA, the Agricultural Efficiency program element received 11 Step-1 proposals and encouraged 7 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

### **PUBLICATIONS (SELECTED)**

Rosenzweig, “Agriculture and Climate Change: Mitigation and Adaptation. Special Issue ‘Challenges in Integrating Mitigation and Adaptation as Responses to Climate Change’” (*Mitigation and Adaptation*, in press; 2005).

Rosenzweig, “Consortium for International Earth Science Information Network (CIESIN) and Socio-economic Data and Applications Center (SEDAC)” (User Working Group; 1993-2004).

Rosenzweig, “Data and Scenarios for Research on Observed Changes in Systems and Sectors. Discussion Paper” (IPCC Task Group on Climate Impact Assessment; 2005).

Rosenzweig, “Effects of climate change on weather and water” (*Environmental Management*, in press; 2005).

Rosenzweig, “Developing synthesis tools for an international program on adapting to climate variability and change: The AIACC Data, Methods, and Synthesis Project” (AIACC Synthesis. In Leary, N. (Ed.) *AIACC Project Book*, in preparation; 2005).

Rosenzweig, “Global Warming” (*Perspectives in World Food and Agriculture*. Vol. 2. The World Food Prize; 2005).

Rosenzweig, “Water resources for agriculture in a changing climate: International case studies” (*Global Environmental Change* 14:345-360; 2004).

Rosenzweig, “Desertification” (*Encyclopedia of Soils in the Environment*. Elsevier. Oxford, UK. pp. 382-389; 2005).

Rosenzweig, “Climate Change and Agricultural Pests.” In Epstein, P. (Ed.). *Climate Change Futures: Confronting Risks, Emerging Opportunities*. A Report of: Climate Change Futures: Health, Ecological and Economic Dimensions” (Center for Health and the Global Environment. Harvard Medical School. Swiss Reinsurance Company. United Nations Development Programme. Cambridge, in press; 2005).

Rosenzweig, “Climate Change, Agriculture, and Development. Incorporating Climate Change into Development Project Planning: Guidance for USAID” (USAID; 2005).

Rosenzweig, “Climate Change and Greenhouse Gas Mitigation: Challenges and Opportunities for Agriculture” (Task Force on Agriculture’s Response to Global Climate Change; 2005).

## CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)

Kempler, “Multi-Sensor Distributive On-line Processing, Visualization, and Analysis Infrastructure for an Agricultural Information System at the NASA Goddard Earth Sciences DAAC” (AGU; Dec. 2004; San Francisco).

Kempler, “An Interoperable, Agricultural Information System Based on Satellite Remote Sensing Data” (ASPRS; Mar. 2005; Baltimore), Comparison of Daily Rainfall from Multi-Satellite Precipitation, Air Force Weather Agency and Mesonet Gauge Analyses Over Oklahoma for Crop Yield Monitoring” (IAMAS; Aug. 2005; Beijing).

Rosenzweig, “Assessment of Observed Changes in Natural and Managed Systems” (*Semester in Environmental Science Distinguished Scientist Seminar*; September 16, 2005; Woods Hole, MA).

Rosenzweig, “Heat is On: Present & Future Impacts of Global Warming” (*Cold Spring Harbor Laboratory; Cultural Series*; May 31, 2005; Cold Spring, Long Island, NY).

Rosenzweig, “Climate Change Impacts: Regional, National, and Global Scales” (*Integrated Program on Global Change Public Lecture Series*; The Environmental Institute; 2005; University of Massachusetts, Amherst, MA).

Rosenzweig, “Energy, Agriculture, and Health: Links to IPCC” (*CLIVAR 2004 Program*; June 24, 2004; Baltimore, MD).

## CONTACT INFORMATION

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## NASA Science Mission Directorate - Applied Sciences Program

### *Air Quality Management – Fiscal Year 2005 Annual Report* \*



#### SUMMARY

The Air Quality Management program element accomplished major milestones and made significant progress in 2005 to support the use of Earth science results, especially Earth science models, in air quality management. The Air Quality team completed a benchmark report on the use of model-derived lateral boundary conditions in EPA's Community Multiscale Air Quality model (CMAQ), and the team completed another benchmark report on the use of land-use models and data in CMAQ. The team worked with EPA and NOAA to successfully transition to operations the use of MODIS aerosol measurements in their air quality forecast activities. In addition, the Air Quality (AQ) team increased its involvement in international air quality activities, such as long-range transport of pollutants, and with national interagency air quality initiatives, such as the U.S. Group on Earth Observations. The Air Quality program received excellent proposals through the Decisions CAN, adding two long-term projects and one short-term project to its portfolio.

NASA, partner organizations, and members of the Air Quality team were honored for their contributions to air quality forecasting activities with the cover of the September 2005 *Bulletin of the American Meteorological Society*. In addition, the Air Quality application team received a NASA Group Achievement Award in June 2005.

#### MAJOR ACCOMPLISHMENTS

##### ***Transition of MODIS Aerosol Forecast Prototype to EPA/NOAA***

Building on the prototype and benchmark report this project completed in FY04, NASA, EPA and NOAA supported the transition of the MODIS Aerosol Forecast, which supports EPA's Air Quality Index, to a near-operational setting based at the Cooperative Institute of Meteorological Satellite Studies (CIMSS, which is a joint NOAA-NASA-University of Wisconsin institute). CIMSS now produces forecast guidance daily, and it issues forecasts within 4 hours of a MODIS image. EPA and NOAA will continue operating the system, training forecasters, and using the tool to support their forecasting responsibilities. <http://idea.ssec.wisc.edu/>

##### ***Benchmarked the Use of Globally Assimilated Lateral Boundary Conditions to Improve CMAQ Ozone Estimates***

NASA and EPA completed this multi-year project to provide and assess lateral boundary conditions generated from a global model output to CMAQ. CMAQ was originally developed for regional scale domains, and this project focused on the use of a multi-scale modeling and data assimilation framework to improve the prediction of large-scale transport and local productions of surface ozone and overall CMAQ performance. The project involved two global ozone assimilation frameworks – Regional Air Quality Modeling System (RAQMS; NASA LaRC-University of Wisconsin) and the Finite Volume Data Assimilation System (FvDAS; NASA GSFC). The project identified that improvements to the vertical resolution of CMAQ and improvements in the convective exchange processes in the middle to upper troposphere may optimize benefits to CMAQ performance from using assimilated lateral boundary conditions. The upper tropospheric ozone concentrations from CMAQ/RAQMS showed increases of up

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\* The FY05-09 Air Quality Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

to 200 ppbv compared to those with the CMAQ/Baseline boundary conditions; CMAQ/RAQMS was in better agreement with ozonesonde observations (100 – 400 ppbv). There were no significant differences in the surface distributions of ozone during the benchmark period between CMAQ/Baseline and CMAQ/RAQMS. These results provided guidance for future CMAQ development plans as part of NOAA's 2005 Air Quality Forecasting System Design Review.

*Note: As part of the project, U.S. EPA graciously agreed to modify Models-3/CMAQ to accept time- and spatially-varying lateral boundary conditions from NASA models and to conduct evaluations of CMAQ performance. These actions are significant indications of EPA's commitment as a partner and the success NASA researchers have had in developing and nurturing interagency partnerships.*

### ***Benchmarked the Use of Growth Models and Land Use Data to Improve Urban Air Quality Model Forecasts***

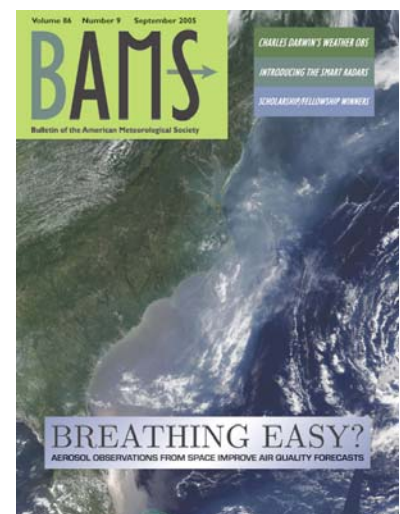
NASA, EPA, and several regional/local organizations completed this multi-year project near Atlanta to assess the use of a land-use growth model (Spatial Growth Model, SGM) and land characteristic data (LandPro99 merged with National Land Cover Data from Landsat) with CMAQ/Models-3 (including MM5 and SMOKE) to improve management options in developing State Implementation Plans (SIP) to meet the National Ambient Air Quality Standards (NAAQS). The specification of land use, which affects land surface energy and water fluxes, affects the near-surface meteorology and emissions. Current tools use numerical models to simulate the physical/chemical processes that govern the formation and transport of criteria pollutants and their precursors. The NLCD/LandPro99 data provide a more accurate representation of the current land use, and the data allow a more robust assessment of future land use changes through the use of SGM.

The project found that use of the high-resolution data improved performance of the MM5 meteorological model substantially compared to the use of traditional land-use data, with the overall daytime cold bias reduced by over 30%. However, the CMAQ air quality model performance for ozone did not show an improvement (increased boundary layer mixing simulated with high-resolution land-use data negated the effects of warmer near-surface air temperatures). In addition, the project used SGM-projected land use changes through 2030 in modeling simulations, which predicted higher urban air temperatures. The incorporation of urban heat island mitigation strategies (e.g., highly reflective roofing and increased tree canopy) proposed by local stakeholder groups partially offset this warming trend.

### ***BAMS Cover for MODIS-based Enhancements to Air Quality Forecasting***

Researchers from the NASA Air Quality team, NOAA, EPA, industry, and academia published a paper on the team's air quality forecasting project in the *Bulletin of the American Meteorological Society* (BAMS, Sept. 2005, 86: 1249-1261). The paper "Improving National Air Quality Forecasts with Satellite Aerosol Observations" was the cover story for the September 2005 issue.

Authors included J. Al-Saadi, J. Szykman, R. B. Pierce, C. Kittaka, D. Neil, D. A. Chu, L. Remer, L. Gumley, E. Prins, L. Weinstock, C. MacDonald, R. Wayland, F. Dimmick, and J. Fishman.  
<http://www.ametsoc.org/pubs/bams/>



## ADDITIONAL ACHIEVEMENTS

The following were significant achievements and developments for the Air Quality application team:

- REASoN Project: DataFed. The DataFed infrastructure provided direct, just-in-time support for the EPA rule-making process for Exceptional Events (Docket EPA-HQ-OAR-2003-0061, National PM-2.5 Designations). The project used DataFed data and analysis tools to evaluate 42 “exceptional aerosol events” for EPA (events flagged by States as being “extra-jurisdictional smoke”). The official docket for the rule-making includes the resulting analysis report, which explicitly and widely used data from MODIS, SeaWiFS and TOMS.  
<http://datafed.net/> and <http://www.regulations.gov/>
- The GSFC Land Information Systems (LIS) group continued work to extend land-atmosphere and biochemical deposition model products and capabilities for use in EPA CMAQ, particularly land-atmosphere ammonia (NH<sub>3</sub>) exchanges. The LIS project uses the MODIS land cover (MOD12) and leaf area index (MOD15) in extending land surface model products to EPA on air quality (and water) issues. LIS work in FY05 examined potential bi-directional fluxes of ammonia, which could identify limitations in the CMAQ modeling approach. <http://lis.gsfc.nasa.gov/>
- NASA (through the Air Quality program) sponsored a special session at the 98<sup>th</sup> Air & Waste Management Association (AWMA) in Minneapolis. The session focused on long-range aerosol transport events, examining the use of satellite observations to support air quality management. NASA also sponsored a booth in the exhibit hall and displayed Earth science atmospheric chemistry data; the Air Quality program shared the booth with NASA Kennedy Space Center, which presented some of NASA’s technology transfer activities).
- Battelle Memorial Institute, through a cooperative agreement between NASA-GSFC and University of Maryland-Baltimore County, completed a report on international air quality treaties, including the identification of opportunities to extend NASA Earth science products to air quality policy activities. The report focused primarily on descriptions and potential NASA Earth science results for the *Convention on Long-Range Transboundary Air Pollution (LRTAP)* and the *U.S.-Canada Bilateral Air Quality Executive Agreement*.
- Work began on the project *Toward the Development of Advanced Data Products from EOS Terra and Aqua Direct Broadcasts for Air Quality Management in the State of Texas*, which was selected through the EOS Continuation NRA in FY04 (PI: K. Hutchinson, U. Texas-Austin). The project focuses on the development of cloud parameters in models for air quality. In FY05, the project made significant improvement in retrieving cloud boundaries (i.e., cloud top bases and heights) from MODIS data, using a new approach developed for air quality modeling applications. Compared to more conventional methods, the new approach reduces errors by an average of 50% (relative to truth). In addition, the project identified that the current MODIS interpolation scheme, which is used to convert between these cloud top parameters, does not adequately consider errors in retrieved cloud top temperatures or effectively utilize moisture profiles in the NCEP analysis fields to make these conversions.
- The program’s Biomass Emissions project delivered satellite-derived fire products for 2002 (EPA’s evaluation year), supporting EPA’s and Regional Planning Organizations’ (RPO) abilities to estimate biomass-burning emissions in a timely and economic manner. The project team demonstrated the value of the NASA fire data by comparing ground and satellite fire data in Florida, showing regions where remotely sensed data could enhance the current area burned and emissions data. The project team presented results at the EPA-NOAA 50th Anniversary Symposium.

In addition, the team supported numerous interagency activities that demonstrated NASA's commitment, roles, and contributions to the air quality community:

- The NASA Air Quality team participated in the development of a landmark international, public/private report *Improving Emission Inventories for Effective Air Quality Management across North America* (NARSTO-05-001). The report examines the current state of inventories in the U.S., Canada, and Mexico, and it provides recommendations for reducing uncertainties, improving compatibility of data and user access, and developing emissions projections. NASA-sponsored Air Quality team scientists (Stefan Falke, Jim Szykman, and Doreen Neil) were among the authors. <http://narsto.org>
- February 2005. NASA participated in EPA's 2005 National Air Quality Conference, which attracts hundreds of national, state, and local air quality forecasters and managers. NASA addressed the audience in plenary to describe the AQ program, give recent results, and introduce upcoming NASA solicitations. This conference also conducted workshops, including a tutorial on how to use MODIS and GOES aerosol optical depth products to support air quality forecasting. <http://airnow.gov>
- May 2005. NASA participated in the Integrated Earth Observation System (IEOS) Public Engagement Workshop *Continuing the Dialogue*. NASA AQ team members supported the air quality near-term opportunity breakout session, including serving as rappateur.
- June 2005. NASA participated in the interagency BlueSkyRAINS (BSR) annual meeting to support planning efforts for BSR evaluation during the 2005 fire season. NASA announced the selection of the BSR-related Decisions CAN proposal to introduce MODIS products into BSR; the PI and several Co-Is and Collaborators were at the meeting. <http://www.blueskyrains.org>
- June 2005. NASA attended a meeting of the Task Force on Hemispheric Transport of Air Pollution within the Executive Body for the Convention on Long-range Transboundary Air Pollution (LRTAP). U.S. EPA serves as a Co-Chair of the Task Force. The meeting addressed three main topics – Observations, Emission inventories and projections, and Regional and global modeling – and the committee proposed to work on an assessment of hemispheric transport in 2005-2009 through a) models, inventories and data intercomparison and evaluation and b) model- and observation-based assessments. A NASA representative attended to identify opportunities for Earth science results to contribute to U.S. interests in LRTAP and will continue to support EPA and U.S. representatives in this activity. <http://www.htap.org>
- Summer-Autumn 2005. NASA participated in the U.S. GEO Near Term Opportunity Working Group on Air Quality. This interagency team developed a white paper to identify priorities for integrated activities that draw on key agency systems for air quality. The five priorities included Integrated Observation-Model Air Quality Fields, Systems for Utilizing Observations to Improve AQ Forecasts, Assessments of Key Air Quality Processes, Improved Emissions Inventories, and Improved International Transport Assessments. Members of the team will present the priorities to OMB, OSTP, and U.S. GEO in FY06. <http://usgeo.gov>
- September 2005. NASA Air Quality team members and USDA representatives met at NASA-Goddard to discuss opportunities for NASA Earth science results to support USDA Air Quality activities. The meeting identified ammonia as a key issue facing USDA. Following the meeting, NASA compiled an assessment of NASA's projects and Earth science results related to ammonia/ammonium for further activities with USDA in FY06.

## SOLICITATIONS

### ***Decisions CAN***

The Air Quality Program received 27 Step-1 proposals in the Decisions CAN and encouraged 10 to submit full proposals. In Step-2, the Air Quality program received 11 full proposals, including 3 that overlapped significantly with the Disaster Management program.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected two Air Quality proposals for awards (the first in conjunction with the Public Health program, the second with the Disaster Management program):

Three-Dimensional Air Quality System

*PI: Ray Hoff, University of Maryland-Baltimore County*

Enhancements to the BlueSkyRAINS Emissions Assessment and Air Quality Prediction System

*PI: Dana Sullivan, Sonoma Technology, Inc.*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the AQ program's portfolio:

Use of Satellite Data to Improve the Physical Atmosphere in SIP Decision Making Models

*PI: Richard McNider, University of Alabama-Huntsville*

### ***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Air Quality Program received 10 Step-1 proposals and encouraged 9 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

## PUBLICATIONS (SELECTED)

Al-Saadi, J., J. Szykman, R. B. Pierce, C. Kittaka, D. Neil, D. A. Chu, L. Remer, L. Gumley, E. Prins, L. Weinstock, C. MacDonald, R. Wayland, F. Dimmick, and J. Fishman, 2005: Improving National Air Quality Forecasts with Satellite Aerosol Observations. *Bulletin of the American Meteorological Society*, 86, 1249-1261).

Falke, S., and S. Ambrose (2005) "Seeing Through Smoke – Earth Observations Enhance Fire and Smoke Decision Support Systems in the Eastern United States" *Earth Observation Magazine*, vol. XIV, no. 6.

Friedl, L., NASA Air Quality Program Team, 2005: Space-based Earth Science Support for Air Quality Management. *EM*, September, 28-32.

Friedl, L., D. Neil, R.B. Pierce, NASA Air Quality Program Team, 2005: Air Quality Management through Earth Observations & Models. *Earth Observation Magazine*, XIV.

Hutchison, K. D., Smith, S. and S. Faraqui, 2005: Correlating MODIS Aerosol Optical Thickness Data with Ground-Based PM<sub>2.5</sub> Observations across Texas for Use in a Real-time Air Quality Prediction System, *Atmospheric Environment*. 38, 7190-7203.

Keith D. Hutchison, Tatyana Pekker, and Solar Smith: Improved Retrievals of Cloud Boundaries with MODIS Data for Use in Air Quality Modeling. *International Journal of Remote Sensing*, in press.

Song, C.-K., D. W. Byun, R. B. Pierce, F. Vukovich, A. Gilliland, A. Al-Saadi: Developing a downscaling method from global to regional ozone modeling: Application for linking RAQMS and CMAQ. *Proceedings of SPIE*, Volume: 5890, p250-258, 2005.

## CONFERENCE/WORKSHOP PRESENTATIONS AND POSTERS (SELECTED)

Chu, D. A., “Satellite observations for air quality application,” invited seminar at The Center for Global and Regional Environmental Research and Department of Geography, Clyde Kohn Colloquium, University of Iowa, September 9, 2005.

Remer, L.A., Y.J. Kaufman, D. Tanré, S. Mattoo, R.G. Kleidman, R. Levy, J.V. Martins, D.A. Chu, C. Ichoku, R.-R. Li, I. Koren, “Towards a global aerosol climatology using MODIS observations.” Presented at the MODIS science team meeting, January 2005.

Remer, L.A., “Satellite observations of long range transport of air pollutants.” Presented at the 1<sup>st</sup> Workshop of the Hemispheric Transport of Air Pollution sub-committee, Brussels, June 2005.

Soja A.J., J. Al-Saadi, J.J. Szykman, W.R. Barnard, C. Kittaka, T. Pace, D.J. Williams, J. Kordzi, and R.B. Pierce. Invited talk, National Regional Planning Organization Technical Meeting, Denver, *Using Satellite-Based Data to Estimate Fire Frequency and Area Burned in the United States*, June 2005.

## PUBLICATIONS RELATED TO AIR QUALITY BY NASA AIR QUALITY RESEARCHERS (SELECTED)

Chu, D. A., L. A. Remer, Y. J. Kaufman, B. Schmid, J. Redemann, K. Knobelspiesse, J.-D. Chern, J. Livingston, P. Russell, X. Xiong, W. Ridgway, Evaluation of aerosol properties over ocean from MODIS During ACE-Asia, *Journal of Geophysical Research*, 110, D07308, doi:10.1029/2004JD005208, 2005a.

Ichoku, C. and Kaufman, Y. J.: A method to derive smoke emission rate from MODIS fire radiative energy measurements, *IEEE Transactions on Geoscience and Remote Sensing*, 43, 2636-2649, 2005.

Kaufman, Y. J., Koren, I., Remer, L. A., Tanré, D., Ginoux, P. and Fan, S.: Dust transport and deposition observed from the Terra-MODIS spacecraft over the Atlantic Ocean., *Journal of Geophysical Research*, 110, D10S12, doi:10.1029/2003JD004436., 2005.

Kaufman, Y. J., Boucher, O., Tanré, D., Chin, M., Remer, L. A. and Takemura, T.: Aerosol anthropogenic component estimated from satellite data., *Geophysical Research Letters*, 32, L17804, doi:10.1029/2005GL023125, 2005.

Levy, R. C., Remer, L. A., Martins, J. V., Kaufman, Y. J., Plana-Fattori, A., Redemann, J., Russell, P. B. and Wenny, B.: Evaluation of the MODIS aerosol retrievals over ocean and land during CLAMS, *Journal of the Atmospheric Sciences*, 62, 974-992, 2005.

Li, C. C., Lau, A. K. H., Mao, J. T. and Chu, D. A.: Retrieval, validation and application of the 1-km aerosol optical depth from MODIS measurements over Hong Kong., *IEEE Transactions on Geoscience and Remote Sensing*, 43, 2650-2658, 2005.

Li, R.-R., Remer, L., Kaufman, Y. J., Mattoo, S., Gao, B.-C. and Vermote, E.: Snow and ice mask for the MODIS aerosol products., *IEEE Geoscience and Remote Sensing Letters*, 2, 306-310, 2005.

Remer, L. A., Kaufman, Y. J., Tanré, D., Mattoo, S., Chu, D. A., Martins, J. V., Li, R.-R., Ichoku, C., Levy, R. C., Kleidman, R. G., Eck, T. F., Vermote, E. and Holben, B. N.: The MODIS aerosol algorithm, products and validation., *Journal of Atmospheric Science*, 62 (4), 947-973, 2005.

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# NASA Science Mission Directorate - Applied Sciences Program

*Aviation – Fiscal Year 2005 Annual Report*<sup>\*</sup>



## SUMMARY

The Aviation program element continued its progress in FY2005, including major presentations on Aviation Safety Action Program (ASAP) research, benchmarking, and integration activities presented at the *11th American Meteorological Society (AMS) Conference on Aviation, Range, and Aerospace Meteorology* and the *22nd AMS Conference on Severe Local Storms*. The Aviation program reported on the detection and characterization of aviation weather constraints and hazards, including in-flight icing, convective weather, aviation turbulence, volcanic ash or gas, and oceanic winds. Extensive publications and presentation of ASAP applications and benchmarks continued throughout 2005 with particular saturation at the *International Symposium on Nowcasting and Very Short Range Forecasting (WSN05)* in September 2005. In FY06, the program will present its further progress at AMS conferences, and the program plans to commence activities to extend research results from the increasingly important issue of space weather effects on aviation.

In FY05, the NASA Aeronautics Research Mission Directorate (ARMD) concluded its 5-year Aviation Safety and Security Program (AvSSP), which served as a stalwart partner to the NASA Applied Sciences Program during the planning, implementation and execution of the initial phase of the Aviation program. ARMD AvSSP was particularly instrumental in fomenting a close professional relationship between Aviation program management and the FAA Aviation Weather Research Program, the Office of the Federal Coordinator for Meteorology, and the interagency Joint Planning and Development Office (JPDO) for the Next Generation Air Transportation System. The Aviation program is particularly proud that AvSSP awarded 12 trophies and 34 certificates for superior aeronautics research to the Applied Sciences Program director, the Aviation program manager and deputy, and various ASAP PIs, researchers and their affiliated laboratories (including NASA-Langley, National Center for Atmospheric Research (NCAR), University of Alabama–Huntsville, MIT Lincoln Laboratory, NOAA Forecast Systems Laboratory, and University of Wisconsin–Cooperative Institute for Meteorological Satellite Studies). In addition, the Aviation program received a NASA Group Achievement Award in June 2005.

## MAJOR ACCOMPLISHMENTS

### *ASAP Research and Applications Accomplishments (with NASA ARMD/AvSSP)*

ASAP began the integration of ASAP cloud microphysical properties derived from NOAA GOES spacecraft into the operational Current Icing Potential product and is examining the potential operational use of products derived from MODIS. The program published a benchmark report on in-flight icing in October 2005, meeting FY05 IBPD metrics 5ESA2, 5ESA6, and 5ESA7. The NASA ARMD awarded a three-year grant to ASAP in 2005 for the use of the Project Columbia Supercomputer for the integration of NASA ASAP icing applications into the NOAA Current Icing Potential forecast product.

ASAP's satellite-based convective initiation products were integrated into NCAR's Auto Nowcast System, and FAA conducted testing on them at the Chicago O'Hare International Airport. Convective weather, with its concomitant impacts on aviation safety and efficiency, is the most significant hazardous weather factor tracked and reported through the National Airspace System. The convective weather

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<sup>\*</sup> The FY05-09 Aviation Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

products rely on Earth science satellite observations from NASA MODIS and NOAA GOES data. Planned enhancements for these products include hyperspectral sounding observations from the next-generation NOAA GOES-R satellite.

NASA began support of the observation and decision support system requirements outlined in the JPDO National Aviation Weather Strategy, advocating on the JPDO's behalf in conjunction with NASA's efforts with the U.S. Group on Earth Observations (USGEO). This activity includes support for the development of aviation weather observing system requirements to underpin the Next Generation Air Transportation System. Earth-Sun system science research activities focus on integrating current ASAP activities with FAA and NOAA efforts in support of the JPDO.

## **ISSUES FOR FY06**

In FY06, the NASA Aeronautics Research Mission Directorate expects to re-plan its three core programs in Aviation Safety, Airspace Systems, and Fundamental Aeronautics. Many aspects of these programs are being formulated to ensure the success of the national initiative being undertaken by the interagency JPDO. The JPDO Aviation Weather Integrated Product Team (IPT) is tasked with developing an integrated aviation weather observing and forecast system that will be able to handle the capacity and safety requirements of the National Airspace System of 2025, which is expected to more than triple in size. The Aviation program has undertaken a major role in the JPDO Weather IPT and contributes a significant number of members to its various sub-teams, including the chairs of the Observations and Sensors sub-teams. During FY06 the Aviation program will continue to strengthen its ties with ARMD, JPDO, FAA, NOAA, and affiliated research institutions to further enhance the societal impact of Earth science observations and research results in support of national aviation priorities.

## **SOLICITATIONS**

### ***Decisions CAN***

The Aviation Program received 12 Step-1 proposals in the Decisions CAN and encouraged 11 to submit full proposals. In Step-2, the Aviation program received 12 full proposals.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected the following Aviation proposals for awards:

Improvement of Operational Aircraft Icing Forecasts and Diagnoses by Assimilation of Satellite Cloud/Surface Properties in the RUC/WRF

*PI: Patrick Minnis, NASA Langley Research Center*

Near Real-time NASA Volcanic Cloud Data for NOAA, FAA, and USGS Decision Support Systems

*PI: Arlin Krueger, University of Maryland–Baltimore County*

The program selected the following proposals for a single, combined project:

Decision Support for Aircraft Avoidance of Convectively-Induced Turbulence Due to Thunderstorms

*PI: Robert Sharman, National Center for Atmospheric Research*

Satellite-Based Prediction of Clear Air Turbulence Associated with Tropopause Folds and Unbalanced Upper-Level Fronts

*PI: Steven Koch, NOAA*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Aviation program's portfolio:

Oceanic Convective Weather Diagnosis and Nowcasting  
*PI: Cathy Kessinger, National Center for Atmospheric Research*

#### **ROSES 2005 – Section A.24**

For the Applied Sciences portion of the ROSES 2005 NRA, the Aviation Program received 7 Step-1 proposals and encouraged all 7 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

#### **PUBLICATIONS (SELECTED)**

Haynes, John A. and John Murray, "NASA Space Systems Enhance Aviation Science for Society," *Earth Observation Magazine*, publication pending.

Lane, T.P., J.D. Doyle, R. Plougonven, M.A. Shapiro, R.D. Sharman, "Observations and numerical simulations of inertia-gravity waves and shearing instabilities in the vicinity of a jet stream," *Journal of the Atmospheric Sciences*, 61, 2692-2706.

#### **CONFERENCE/WORKSHOP PRESENTATIONS AND POSTERS (SELECTED)**

Ackerman, S. A., M. Richards and W. F. Feltz 2004: "Estimating the height of volcanic plumes from the 15 micron CO<sub>2</sub> band," American Geophysical Society, 13-17 December 2004, presentation.

Avery, M.A., J. J. Murray, J. V. Plant, T. Hock, E. Korn and C. Martin, "Water Vapor, Temperature and Ozone Measurements and Variability: Preliminary Case Studies from the North Atlantic THORPEX Regional Campaign," *First THORPEX Science Symposium*, Montreal, 2004.

Bedka K.M., W. F. Feltz, J. R. Mecikalski, R. A. Petersen, and C. S. Velden, "Statistical relationships between satellite-derived mesoscale atmospheric motion vectors and NOAA wind profiler network observations," *12th Conference on Aviation, Range, and Aerospace Meteorology*, 30 January-2 February, 2006. Atlanta, Georgia.

Bedka, K. M. and J. R. Mecikalski, 2005: Multi-Sensor Convection Analysis. *5th Annual Workshop on Hyperspectral Science of UW-Madison MURI, Airborne, LEO, and GEO Activities*, Madison, WI.

Bedka, K. M., J. R. Mecikalski, and W. F. Feltz, "Analysis of cumulus cloud motion and growth toward nowcasting convection and lightning initiation," *CIMSS 25th Anniversary Symposium on Satellite Meteorology: Past, Present and Future*. 11-13 July 2005, Univ. of Wisconsin-Madison, Madison, Wisconsin.

Bedka, S. T., W. F. Feltz, A. J. Schreiner, and R. E. Holz, "ASAP CONUS Cloud Top Height Validation," *ASAP Science Meeting*, 13-14<sup>th</sup> April 2005.

Bedka, K. M., J. R. Mecikalski, S. J. Paech, T. Berendes, and U. Nair, 2004, "Forecasting convective initiation by monitoring the evolution of moving cumulus in daytime GOES imagery," *11<sup>th</sup> Conf. on Aviation, Range, and Aerospace Meteorology*, and *22<sup>nd</sup> Conf. on Severe Local Storms*, Hyannis, MA.

Berendes, T., and J. Mecikalski, 2005, "Detection of convective clouds and volcanic ash in satellite imagery using an iterative statistical clustering method," *International Symposium on Nowcasting and*

*Very Short Range Forecasting (WSN05)*, Meteo-France, Toulouse, France, 5-9 September 2005.

Feltz, W. F., J. R. Mecikalski, J. J. Murray, D. B. Johnson, K. Bedka, S. M. Bedka, S. M. Thomas, A. J. Wimmers, M. Pavolonis, S. Ackerman, M. Richards, and N. Ulhenbrock, 2005, "Satellite-derived Aviation Hazard Products at the University of Wisconsin: Convection, Turbulence, Volcanic Ash, and Winds," Proceedings from the *World Weather Research Program Symposium on Nowcasting*, Toulouse, France, 5-9 September 2005

Feltz, W. F., 2005, "LEO/GEO Applications for Aviation," *5<sup>th</sup> Annual Workshop on Hyperspectral Science of UW-Madison MURI, Airborne, LEO, and GEO Activities*, Madison, WI.

Feltz, W. F., J. R. Mecikalski, J. J. Murray, D. B. Johnson, K. M. Bedka, S. M. Thomas, A. J. Wimmers, S. A. Ackerman, and C. C. Schmidt, "The Advanced Satellite Aviation-weather Products (ASAP) initiative at the University of Wisconsin – CIMSS," *21<sup>st</sup> IIPS Conference*, San Diego, CA, 9-13 January 2005, preprints, poster presentation.

Feltz, W. F., J. J. Murray, K. M. Bedka, S. M. Bedka, M. Pavolonis, A. J. Wimmers, S. A. Ackerman, M. S. Richards, and N. L. Uhlenbrock, 2005, "Satellite-based Aviation Weather Applications for Convection, Visibility, Turbulence, and Volcanic Ash," *CIMSS 25<sup>th</sup> Anniversary Symposium*. 11-12 July 2005  
Madison, WI.

Feltz, W. F., J. R. Mecikalski, J. J. Murray, D. B. Johnson, K. M. Bedka, S. M. Thomas, A. J. Wimmers, and C. C. Schmidt, 2004, "The Advanced Satellite Aviation-Weather Products (ASAP) initiative at the University of Wisconsin – CIMSS," Preprints, *13<sup>th</sup> Conf. on Satellite Meteorology and Oceanography*.

Wimmers, A. and W. Feltz, "Estimating Regions of Tropopause Folding and Clear-Air Turbulence with GOES Water Vapor Channel," Proceedings from the *World Weather Research Program Symposium on Nowcasting*, Toulouse, France, 5-9 September 2005.

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# NASA Science Mission Directorate - Applied Sciences Program

## *Carbon Management – Fiscal Year 2005 Annual Report* \*



### SUMMARY

The Carbon Management program element develops partnerships with federal agencies and other organizations that have responsibilities for monitoring and managing emissions and sequestration of carbon. To date the program has focused on the sequestration of carbon in terrestrial systems and the enhancement of tools, such as Carbon Query and Estimation Tool (CQUEST) and the Terrestrial Observation and Prediction System (TOPS), that use NASA Earth observations and model results to provide more accurate information on the likelihood to store carbon in specific terrestrial environments. The Carbon Management program element works closely with the Carbon Cycle and Ecosystems Focus Area within the NASA Earth Science Division.

In FY05, the program initiated several projects selected under the 2004 NASA Carbon Cycle solicitation, including cost-sharing with the Earth Science Research Program or USDA. The program made significant progress on projects initiated in 2004 and 2005, and the program expects verification and validation of the products from these projects in 2006.

### MAJOR ACCOMPLISHMENTS

#### ***CQUEST – Carbon Query and Evaluation Support Tools***

CQUEST is an internet-based query and modeling application that allows users to model carbon sinks and CO<sub>2</sub> fluxes in agricultural and forest ecosystems for any location within the United States. CQUEST is based on the use of Earth science products derived from MODIS and is integrated with the NASA-developed CASA model. The tool is currently being evaluated on its ability to predict and monitor carbon sequestration by organizations in USDA and DOE.

<http://geo.arc.nasa.gov/website/cquestwebsite/>

In FY05, the CQUEST project team completed a U.S. national carbon sequestration inventory using MODIS 1-km land surface products and completed an historical reconstruction of U.S. carbon pool baselines for the past 20 years using AVHRR 8-km land surface products. The team also completed a national analysis of soil carbon changes resulting from land use change. In FY06, the CQUEST team will generate CASA model products for net primary production (NPP) annual carbon flux and above ground carbon pools for priority USDA study sites, and it will integrate CERES satellite products into CASA model results.

#### ***Linking Landscape-Scale Carbon Monitoring with Forest Management***

The Carbon program initiated this project in FY05, and the project team developed correlations between USDA/Forest Service Forest Inventory and Assessment forest types, MODIS land classes, and CASA land classes. The project also completed biometric measurements for study sites to measure carbon stocks and began evaluating the use of AVHRR and MODIS data in CASA for current and historical carbon inventories. In FY06, the project team will estimate and map carbon stocks and productivity for landscape sites using LiDAR and other resources. The project will also link models to multi-scale data sets and integrate CERES satellite products into CASA model results.

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\* The FY05-09 Carbon Management Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

### ***Global Land Cover Facility***

The Global Land Cover Facility (GLCF) develops and distributes remotely sensed satellite data and products that explain land cover from the local to global scales. In FY05, the project team standardized over 2000 Landsat scenes and ingested an additional 630 Landsat scenes, developed MODIS enhancements plan and processing, extended data sharing technologies and plan for the continuation of data grids and the Open-source Project for a Network Data Access Protocol (OPeNDAP), and contributed to the United Nations Environment Program's report *One Planet, Many People*. The GLCF archive is open to researchers; FY05 downloads from this archive totaled 104,493,091 MB, and the project team responded to 1,250 requests for assistance. In FY06, the project team will ingest additional MODIS data and complete visualization enhancements. <http://glcf.umiaccs.umd.edu/index.shtml> and <http://opendap.org/>

### ***Development of a Framework and Modeling Tool for Spatially-Explicit Full Carbon and Greenhouse Gas Accounting at the Regional to National Scale***

Initiating this project in FY05, the project team completed the delineation of land cover using Landsat, and the team combined this product spatially with respective soils data and crop management data. The project team completed empirical estimates of soil carbon change at 1-km resolution and developed a soil carbon base map that is adjusted based on a history of crop management. The project team also developed a method to include sequestration adoption risks in the Policy Analysis System (POLYSYS) economic model. In FY06, the project team will pursue activities leading to a full integration of remote sensing data, land-use scenarios, and soil management approaches into the POLYSYS economic model.

### ***Decision Support Systems for Carbon Management across the U.S. Corn Belt using NASA Remote Sensing Data Products***

The Carbon program initiated this project in FY05, and the project team mapped residue management and tillage practice across the study swath in Iowa, Illinois and Indiana and developed a database for the study area. The project also calibrated the EPIC-Century model (Erosion Productivity Impact Calculator). In FY06, the project team will continue these tasks and evaluate the decision tool for carbon management practices.

## **CARBON CYCLE PROJECTS**

In 2005, the Carbon Management program initiated three projects that were selected under the 2004 NASA Carbon Cycle solicitation. These five-year projects are co-funded by the Applied Sciences Program and either the Earth Science Research Program or the carbon management element of the USDA Cooperative Research Education and Extension Service (CSREES).

### ***Projections of Land-Use Change and the Carbon Cycle***

Initiated in March 2005, the project team developed tools for data integration and manipulation. In FY06, the project team will implement a terrestrial carbon-cycle model, begin parameter estimation using a coupled model, and use software tools to enhance Integrated Assessment Models (IAM) representations of wind and solar energy.

### ***CO<sub>2</sub> Fluxes between Agricultural Lands and the Atmosphere: Towards More Complete Accounting by Integrating Remote Sensing with Simulation Modeling***

Initiated in June 2005, the project team completed a U.S. national carbon sequestration inventory using MODIS 1-km land surface products. This inventory will form the basis for an integrated analysis of past trends in coupled framework with the Century model. The project team also completed a national carbon assessment for soil carbon stock changes in agricultural lands using Century, and this assessment will be used as the basis to form the CASA-Century combined assessment during this project. In FY06, the

project team will conduct model testing for a combined CASA-Century framework and will establish a benchmark sampling network for carbon stocks.

### ***North American Forest Disturbance and Regrowth Since 1972: Empirical Assessment with Field Measurements and Satellite Remotely Sensed Observations***

Initiated in February 2005, the project team (working with the USDA Forest Service's Forest Inventory and Assessment (FIA) project) developed methods to produce Landsat-based "data cubes" for use in FIA. Contacts in each of the FIA regions work with the project team to compare the data cubes with FIA field measurements. In FY06, the project team will complete the first analysis of data cubes in each FIA region and evaluate the potential of FIA adopting this technology.

## **ADDITIONAL ACTIVITIES & ISSUES FOR FY06**

In FY05, the Carbon Management program manager continued his role as one of two NASA representatives on the Carbon Cycle Interagency Working Group of the Climate Change Science Program.

In FY06, the Carbon Management program element will pursue activities that extend carbon management activities to aquatic and oceanic systems. The program will begin the evaluation of NASA observations relevant to carbon management that will be acquired from new Earth observing systems in the next three years, such as the Orbiting Carbon Observatory (OCO). In addition, the program will begin the first project focused on the evaluation of NASA capabilities for carbon sequestration managed by and within the private sector; the program expects an evaluation report by the end of 2006.

## **SOLICITATIONS**

### ***Decisions CAN***

The Carbon Management program element received 9 Step-1 proposals in the Decisions CAN and encouraged 4 to submit full proposals. In Step-2, the Carbon Management program element received 7 full proposals.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected the following Carbon Management proposals to be combined into a single three-year project:

Decision Support for Loblolly Pine Carbon Management: From Research to Operations  
*PI: Randolph Wynne, Virginia Polytechnic and State University*

Integration of Decision Support Tools for Managing Carbon Sequestration in the U.S. Forest Sector  
*PI: Chris Potter, NASA Ames Research Center*

### ***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Carbon Management program element received 4 Step-1 proposals and encouraged 2 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

## **PUBLICATIONS (SELECTED)**

Ryan, M. with B. Law, "Interpreting, measuring and modeling soil respiration," *Biogeochemistry*, Vol. 73, No. 1, March 2005, pp. 3-27.

### **CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)**

Doriaswamy, P., “Simulation of Erosion and Soil Carbon Sequestration over an Agricultural Landscape in Iowa” (Baltimore, Maryland; March 21-24, 2005 – USDA Symposium on Greenhouse Gases and Carbon Sequestration in Agriculture and Forestry).

Ogle, S. with C. Potter, “Past Impacts and Future Scenarios of Climate on Ecosystem Carbon Balance for the Western United States” (Sacramento, CA; September, 2005 - Second Annual Conference on Climate Change in the Western United States).

Townshend, J., “Large Volume Data Systems” (San Diego, CA; 2005 – ESRI Users Conference).

Townshend, J., “The GLCF and Biodiversity Conservation” (Washington, DC; August 29, 2005 – NASA Biodiversity and Ecological Forecasting Meeting). “Improving Automated Detection of Forest Cover Change for Large Areas using Landsat Data” (Biloxi, Mississippi; May 2005 – MultiTemp 2005).

West, T., “A Farm-Level Evaluation of Conditions under Which Farmers Will Supply Biomass Feedstocks for Energy Production” (July 24-27, 2005 – American Agricultural Economics Association Annual Meeting, Providence, RI).

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## NASA Science Mission Directorate - Applied Sciences Program

### *Coastal Management – Fiscal Year 2005 Annual Report* \*



#### SUMMARY

The Coastal Management program element made progress to support use of NASA Earth science observations and models in coastal management. A Coastal Management project provided daily, near-real-time MODIS ocean data products as well as multi-temporal animation products fused with Navy Coastal Ocean Model (NCOM) modeling outputs to NOAA's Harmful Algal BloomS Observing System (HABSOS) for use by Gulf of Mexico coastal resource managers. This project also provided system training to employees at Naval Research Lab (NRL), NOAA, and other organizations to extend derived Earth science products into HABSOS (including related HAB Mapping System, HAB Bulletin, and HAB Forecasting System). Building on the FY04 evaluation report of HAB decision support systems, the Coastal Management team developed a joint agency work plan and completed the verification and validation (V&V) assessment of REASoN project contributions to HABSOS.

The Coastal team completed a white paper on potential applications of Earth science results to regional sediment management systems and a report on decision support systems related to sea level change. During the Applied Sciences Program's development of a rapid prototyping capacity in FY05, the coastal management activities served as an initial pathfinder application. Through the Decisions solicitation, the Coastal Management program added three one-year projects to its portfolio (oil spills, marine mammal avoidance, and coastal pollution), which begin in FY06. The Coastal Management program frequently participated in NASA's activities to support the Administration's Ocean Action Plan, especially the Subcommittee on Integrated Management of Ocean Resources and the Gulf of Mexico Alliance.

#### MAJOR ACCOMPLISHMENTS

##### ***REASoN: Progress on Incorporating Earth Science Results in HAB Bulletin/Mapping System***

NASA and the NRL/Applied Coherent Technologies (ACT) REASoN team integrated real-time ocean measurements from NASA and NOAA satellites, available coastal observations, and coastal ocean model outputs into the NOAA HABSOS automated near-real-time data base and distribution system for the Gulf of Mexico, the HAB Bulletin, and the HAB Mapping System. The HAB Bulletin provides near real-time information on bloom location, wind speed and direction, satellite chlorophyll estimates, and bloom spatial coverage to the Gulf of Mexico coastal community. The REASoN project also worked to enhance future HAB Bulletins through integration of MODIS ocean data products and NCOM modeling output.

<http://www.csc.noaa.gov/crs/habf/habmaps.html> and <http://www.ncddc.noaa.gov/habsos>

##### ***Coastal Management a Pathfinder in Rapid Prototyping Capacity***

The Coastal Management program element served as a pathfinder in the Applied Sciences Program's development of a Rapid Prototyping Capacity (RPC), specifically focusing on the verification and validation of Earth science products in HAB decision support tools and the Coral Reef Early Warning System (CREWS). The purpose of a RPC is to quickly evaluate Earth science results for their value to a decision support system, propose configurations of the results, and assess the any improvements to determine if a more significant project is appropriate. In FY05, the RPC activities with Coastal

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\* The FY05-09 Coastal Management Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

Management specifically focused on the verification and validation of REASoN-project contributions to HABSOS. The RPC of Earth science products in HABSOS enabled a demonstration of additional desired functionality that is not presently available using the current software configuration of HABSOS. In addition, the Coastal team developed a joint agency plan for the V&V of the Coral Reef Early Warning System (CREWS) with a strong RPC component. <http://www.coral.noaa.gov/crews/>

## **ADDITIONAL ACHIEVEMENTS**

The Coastal Management team completed the following significant products in FY05:

- White paper on decision support systems related to sea level change. This paper discussed decision support systems used to assess sea level change, reviewed needs and requirements for the monitoring and assessment of sea level change, and discussed the potential for NASA Earth science research results to contribute to decision support systems for sea level change assessment. The paper specifically recommends that WAVE-Current Information System (WAVCIS) be considered as a decision support system with potential for enhancement via NASA contributions.
- White paper on the U.S. Army Corps of Engineer's Regional Sediment Management System (RSMS). This paper reviewed the RSMS decision support tool and discusses the potential for current and planned NASA Earth science results, products, and modeling output to contribute. <http://aiwg.gsfc.nasa.gov/dss.html>
- Report on an assessment of Federal agency strategic plans related to coastal management. This report reviewed strategic plans of Federal agencies involved with coastal management in order to identify common goals and potential for partnership. The report also discussed NASA's participation in national and international non-governmental organizations involved with coastal management.

In addition, the team supported numerous interagency activities that served to demonstrate NASA's role and commitment in the coastal community:

- Ocean Action Plan & SIMOR: The Coastal Management program participated in supporting NASA's contributions to the Administration's Ocean Action Plan, especially the Subcommittee on Integrated Management of Ocean Resources.
- Gulf of Mexico Alliance: The Coastal Management team attended meetings and participated in teleconferences regarding planning and collaborative work by the Gulf of Mexico Alliance partners. <http://www.gulfofmexicoalliance.org/index.html>
- April 2005: The Coastal Management team presented Earth science applications activities at the Ocean Color Research Team Meeting. The talk emphasized NASA activities related to the Research & Operations activities undertaken by NASA and NOAA to streamline the transition between operations and research.
- July 2005: The Coastal Management team attended the NOAA Coastal Zone 2005 conference. The meeting presented numerous opportunities to engage coastal resource managers on the use of NASA Earth science results.
- July 2005: The Coastal Management team attended the 2005 ESRI User Conference, presenting a poster on remote sensing techniques for producing coastal land water masks.

## SOLICITATIONS

### ***Decisions CAN***

The Coastal Management program element received 33 Step-1 proposals in the Decisions CAN and encouraged 15 to submit full proposals. In Step-2, Coastal Management received 18 full proposals, including 7 that overlapped significantly with the Ecological Forecasting program and 4 with the Disaster Management program. Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program did not select any Coastal Management proposals for awards since the higher-scoring coastal proposals did not align with the Program's FY05 direction and priorities.

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including three projects for the Coastal Management portfolio:

MODIS Products to Improve the Monitoring of Gas Flarings from Offshore Oil and Gas Facilities

*PI: Sonia Gallegos, Naval Research Laboratory*

Impacts of NASA Data and Models on Decision Support Tools in Prince William Sound and Alaska Coastal Oceans

*PI: Stephen Okkonen, University of Alaska-Fairbanks*

Predicting Right Whale Distributions from Space: An Operational System for Marine Ecosystem Modeling

*PI: Andrew Pershing, Cornell University*

### ***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Coastal Management program element received 11 Step-1 proposals (five overlapped with other applications) and encouraged 8 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

## PUBLICATIONS & CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)

Arnone, R. A., A. R. Parsons, D. S. Ko, B. Casey, S. Ladner, R. H. Preller, and C. M. Hall. 2005. "Physical and bio-optical processes in the Gulf of Mexico - Linking real-time circulation models and satellite bio-optical and SST properties," presented at the 8<sup>th</sup> *International Conference for Marine and Coastal Environments*, May 17–19 in Halifax, Nova Scotia.

Blain, C. A., R. A. Arnone, and R. W. Gould. 2005, "High resolution coastal circulation: Merging models and ocean color data," presented at the 8<sup>th</sup> *International Conference for Marine and Coastal Environments*, May 17–19 in Halifax, Nova Scotia.

Friedl, L., C. Hall. 2005, "Extending the Use of NASA Research Results for Coastal Management Decision Support," *Earth Observation Magazine*, XIV.

McPherson, T., R. Beard. 2005, "NASA-NOAA Collaboration on the Harmful Algal BloomS Observing System (HABSOS)," Presentation, Gulf of Mexico Program Management Committee Meeting, April 12-13, 2005.

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# NASA Science Mission Directorate - Applied Sciences Program

## *Disaster Management – Fiscal Year 2005 Annual Report* \*



### SUMMARY

The Disaster Management program element assisted with the NASA response to specific disasters in FY05, and the program's activities addressed the integration of NASA Earth science results into preparations and decision support for a wide range of disasters, such as wildfires, earthquakes, flooding, hurricanes, landslides, and droughts. The program developed numerous evaluation, validation and verification, and benchmark reports, and the program added 5 projects from the *Decisions* solicitation to its portfolio.

The NASA Short-term Prediction Research and Transition Center (SPoRT), located at NASA-Marshall and supported by the Earth-Sun System Division and the Disaster Management Program element, received a 2005 NASA Group Achievement Award for improving the Nation's weather prediction capabilities through the use of NASA-developed satellite data and forecasting technology in the National Weather Service Forecast Office environment.

### MAJOR ACCOMPLISHMENTS

#### ***Support to East Asian Tsunami Response***

NASA, through the Disaster Management program and other efforts, provided support to the U.S. response to the East Asian Tsunami in December 2004. The Disaster Management program supported NASA's efforts to coordinate with interagency efforts, providing high-resolution ocean and land-cover measurements from EO-1, Landsat, and MODIS space-based instruments that emergency relief organizations could use to identify some of the hardest hit areas and to assess the extent of the damage.

#### ***Support to Hurricane Katrina Response***

NASA, through the Disaster Management program and other efforts, provided support to the response to Hurricane Katrina in August and September 2005. Among the Disaster Management program's activities, the Socioeconomic Data and Applications Center (SEDAC) User Working Group disseminated preliminary gridded dataset on population and housing characteristics for Alabama, Louisiana, and Mississippi based on the 2000 census (resolution of 30 arc seconds). The team provided this dataset to the National Institute of Environmental Health Sciences (NIEHS) for evaluation and use in the federal response and planning related to the public health and environmental effects of Hurricane Katrina. The team also prepared a grid for the New Orleans metropolitan statistical area at 7.5' resolution (about 250 m). The University Consortium for Geographic Information Science (UCGIS) and the American Sociological Association provided links to these datasets.

<http://beta.sedac.ciesin.columbia.edu/katrina2005.html>

#### ***SENH Results***

In May 2005, the Disaster Management program element held a workshop for the ten Solid Earth and Natural Hazards (SENH) projects, which were funded in 2001 from a legacy effort under the former Hazards Program and are scheduled for completion in FY06. The Disaster Management program worked with the U.S. Geological Survey (USGS) EROS Data Center (EDC) to host a review of the SENH applications projects. The review included technical progress reports from all ten project teams,

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\* The FY05-09 Disaster Management Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

discussions of the alignment of the SENH projects with the Applied Sciences program, and a number of special presentations by EDC staff about USGS Disaster Management and Natural Hazards activities. The results of this workshop encouraged the principal investigators to fit their results to the systems engineering approach; final reports are expected in FY06.

### ***Subcommittee on Disaster Reduction***

The Disaster Management program has been very active in the Subcommittee on Disaster Reduction (SDR). The Disaster Management program manager is co-chair of the Remote Sensing Applications Working Group, which changed its name in FY05 to the Earth Observation Working Group (EOWG). NASA team members participated in the Grand Challenges review, and SDR published the final *Grand Challenges Report*. In FY06, the project team will proceed with the specific implementation plans for each Grand Challenge. <http://www.sdr.gov>

### ***WSSD/CEOS***

The Disaster Management program continued to support the World Summit on Sustainable Development (WSSD) Type-2 Partnerships in Disaster Management and Conflict, which satisfies the WSSD goals as highlighted in the Committee on Earth Observation Satellites (CEOS) Module III guidelines. The program initiated a partnership with the European Global Monitoring for Environment and Security (GMES) and European Space Agency's TIGER effort. Together with Mississippi State University and the University of South Carolina, the program established African projects using NASA data. In FY05, the program initiated a collaborative project focused on sustainable development opportunities in Africa. The initial phase of the project, scheduled for completion in FY06, seeks to identify NASA science capacity that could contribute to the Disaster Management and Conflict Module of the CEOS Follow-Up Program. The project team developed a survey instrument to identify decision support system opportunities and NASA research projects that may contribute to the WSSD effort.

### ***Hazards U.S. Multi-Hazard (HAZUS-MH) Project***

Work on Year 2 of the HAZUS-MH project continued in collaboration with the National Institute of Building Sciences (NIBS) and Applied Research Associates (ARA). This project seeks to improve the coastal risk assessment methodology in the HAZUS-MH decision support system through the integration of NASA modeling and remote sensing tools. In December 2004, NASA and ARA presented results of the technical work accomplished during Year 1 to the Technical Oversight Committee for this project. The project team reported on results of the HAZUS-MH sensitivity analysis, topographic and bathymetric data inventory, initial results of the remote sensing approaches to estimating aerodynamic surface roughness ( $z_0$ ), and initial efforts to validate remote sensing-derived surface roughness values. Team members presented technical results at the Joint Agency Commercial Imagery Evaluation (JACIE) conference and at the American Society for Photogrammetry and Remote Sensing (ASPRS) annual meeting.

The project team made significant progress in FY05. The team developed an Interactive Data Language (IDL) process to directly derive surface roughness values from LiDAR data using a number of published algorithms. The project team used this tool to develop a 1-km resolution surface roughness map of the Broward County, FL study area to be evaluated against the current land use/land cover  $z_0$  approach (using the 1992 NLCD), which is the HAZUS default. The team also developed and validated an ASTER-based 15-m land cover classification for the Pender/Onslow County study area in North Carolina; overall classification accuracy was 88%. The project team acquired the 2001 National Land Cover Dataset (NLCD) derived from Landsat data for the study area. In FY06, the team will convert the ASTER and 2001 NLCD classifications to surface roughness maps using updated  $z_0$  lookup tables and then compare the results of HAZUS-MH with and without the ASTER/NLCD derived products.

In FY05, ARA initiated the integration of the WAVEWATCH III (WW3) deepwater wave model into HAZUS-MH for improved loss estimates as a result of storm surge associated with hurricanes. The project team conducted test runs of HAZUS-MH with and without results from WW3, serving as the basis of a HAZUS/WW3 benchmark report. The program expects to complete the benchmark report in early FY06 due to impacts and delays from Hurricane Katrina. The new version of HAZUS-MH, which incorporates WW3, is not expected to be publicly released until 2007.

#### ***AWIPS Systems Engineering and Evaluation***

The project team produced a quick-look evaluation for the Advanced Weather Information Processing System (AWIPS) decision tool. The evaluation examined inputs, outputs, and opportunities for NASA-derived solutions that may benefit the system.

#### ***Hurricane Flood and Landslide Project (HFL): Detecting Tropical Floods and Landslides using NASA-based Precipitation Information***

The program initiated activities in this HFL project, which is an interagency project to improve hurricane, flood, and landslide prediction capabilities for decision makers. This project extends NASA datasets of precipitation and land surface characteristics for use in quasi-global flood and landslide decision tools (developed by USGS and NOAA partners for USAID and NOAA/NWS use) for use in disaster management, response, preparedness and mitigation activities around the globe. The project will build on prior NASA work in the production of quasi-global precipitation information in real-time.

#### ***Fire Radiative Energy (FRE) Project***

The Disaster Management program initiated a fire radiative detection study to further estimate the intensity of fire and aerosol production; this study is in partnership with the Air Quality program. In FY05, the project identified the basic relationship between the MODIS-measured FRE release rates and smoke aerosol emission rates. The project team performed the foregoing analysis using MODIS global fire and aerosol data acquired throughout 2002, and it derived  $C_e^{PM}$  for various biomass-burning regions.

The project team conducted an analysis to ensure that the developed methodology works globally. In FY06, the project team will extend this analysis to encompass five years of MODIS data in order to confirm the methodology and to derive  $C_e^{PM}$  for the entire North America at 1° resolution.

#### ***Southern Thunder***

This project seeks to transition total lightning observations from the TRMM satellite (i.e., Lightning Imaging Sensor (LIS)) and ground-based research networks to improve the short-range prediction of severe weather. The project builds on U.S. Weather Research Program and the World Meteorological Organization efforts to foster a national Nowcasting Test Bed; the team involves government, university, and industry partners.

In FY05, the project completed an initial total lightning verification, validation and benchmarking in AWIPS in collaboration with the NWS forecast offices at Huntsville (HUN) and Nashville (BNA). The project team presented the results at the *NWS Severe Weather Technology Workshop* in Silver Spring, Maryland. The team supported a community workshop in July 2005, which included a progress review and a reassessment of the end users' priorities. The project team developed several new training modules and presentations for the new MODIS and AMSR-E data products available in the Weather Forecast Office (WFO) via AWIPS. SPoRT is working with the UCAR/COMET program to convert these presentations to VISITview modules. Project team members gave the WFO HUN staff a presentation and overview of the new convective initiation products available within the AWIPS system. WFO HUN forecasters are now utilizing these products operationally, and an assessment period will occur in the future.

### ***REASoN: Wildfire Research and Applications Partnership (WRAP) Report***

The WRAP project extends NASA science and technology development in fire imaging to assist the U.S. Forest Service (USFS) in improving information gathering, reporting and managing of wildfire events. This project focuses on three main arenas of technology development: imaging technologies in thermal and mid-wave IR; test and evaluation of data telemetry technologies; and, strategies for improved data and information handling for decision support systems.

The project team continued to develop new algorithms for characterizing fire from MODIS, ASTER and airborne imagery. This effort complements work with the USFS to understand the value of different spectral bands for improved fire discrimination.

To evaluate the applicability of advanced platform technology, the project team held a demonstration of small unmanned aerial vehicles (UAVs) in July 2005. (The project delayed the Western States Mission, which is a demonstration on the Altair aircraft, until 2006.) The project team made enhancements to the Airborne Infrared Disaster Assessment System (AIRDAS) for use in the 2005 fire season. NASA-Ames and Fireball, Inc. developed a Space Act Agreement partnership to allow private enterprise modifications of the AIRDAS for improved utility for fire imaging. Fireball now uses the AIRDAS 3 (the most recent upgrade), and AIRDAS is one of three systems that USFS recognizes as a “Type 1” fire imaging system.

### ***REASoN: Development of Remote Sensing-assisted Natural and Technological Hazards Decision Support Systems: University of South Carolina***

This REASoN project entails four sub-projects – three on enhancements to spatial decision support systems related to natural and technological hazards and one on education and technology transfer from the other sub-projects. The three sub-projects address modeling of human risk and vulnerability to hazards, identifying remote sensing assets available at a disaster through a hazard guidance system, and improving technological hazards management through hazardous waste site monitoring tools.

In FY05, the project made significant progress in surveying the needs of state and federal response managers. The Savannah River National Laboratory (SRNL) joined the project, along with the University of South Carolina and U.S. EPA, to give hazard response personnel better access to needed information. SRNL’s role in the project is to focus on the development of high resolution remote sensing methodologies (e.g., hyperspectral) to detect imminent failure of closure caps, such as those used to close and protect areas where hazardous and radioactive waste has been disposed. SRNL partners are conducting tests at a set of experimental closure caps constructed near the Savannah River Site Burial Ground Complex.

## **SOLICITATIONS**

### ***Decisions CAN***

The Disaster Management program received 74 Step-1 proposals in the Decisions CAN and encouraged 51 to submit full proposals. In Step-2, the Disaster Management program element received 52 full proposals, including 22 that overlapped with other program elements.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected several Disaster Management proposals for awards. The Program selected one Disaster Management project in conjunction with Air Quality:

Enhancements to the BlueSkyRAINS Emissions Assessment and Air Quality Prediction System  
*PI: Dana Sullivan, Sonoma Technology, Inc.*

The Applied Sciences Program selected the following proposals for a single, combined project serving the Disaster Management and Water Management program elements:

Use of NASA Remote Sensing Datasets in NOAA National Weather Service River Forecast Centers' Hydrologic Modeling

*PI: Ashutosh Limaye, Universities Space Research Association*

Improving NOAA/NWS River Forecast Center Decision Support with NASA Satellite and Land Information System Products

*PI: Pedro Restrepo, NOAA*

The Program selected the following proposals for a single, combined project serving the Disaster Management and Water Management program elements:

National Drought Monitoring System for Drought Early Warning Using Hydrologic and Ecologic Observations from NASA Satellite Data

*PI: Son V. Nghiem, NASA–Jet Propulsion Laboratory*

Enhancement of the U.S. Drought Monitor by Integrating NASA Earth Science Data

*PI: James Verdin, USGS EROS Data Center*

The Program selected the following proposals for a single, combined project serving the Disaster Management, Public Health, and Agricultural Efficiency program elements:

Integrating NASA Earth Science Results into Malaria Early Warning Products to Enhance USAID Food Security and Disaster Management Decision Making

*PI: James Verdin, USGS EROS Data Center*

Enhancing the Famine Early Warning System Network Decision Support System with NASA Earth System Science Data and Modeling Results

*PI: Molly Elizabeth Brown, NASA Goddard Space Flight Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Disaster Management program portfolio (in conjunction with the Water Management program):

Flood Inundation Enhancement for NOAA's Advanced Hydrologic Prediction Service

*PI: G. Robert Brakenridge, Dartmouth College*

## **PUBLICATIONS (SELECTED)**

Ambrose, S., S. Habib, and R. McKellip, "Extending NASA Research Capabilities For Disaster Management," *EOM*, August 2005.

Ambrose, S. (contributor), *Know Risk*, published by UN prior to Kobe Disaster Management Workshop, December 2004.

Golden, M., R. Downs, and K. Davis-Packard, *Confidentiality Issues and Policies Related to the Utilization and Dissemination of Geospatial Data for Public Health Applications*, March 2005. [http://www.ciesin.columbia.edu/pdf/SEDAC\\_ConfidentialityReport.pdf](http://www.ciesin.columbia.edu/pdf/SEDAC_ConfidentialityReport.pdf).

Ambrose, S., and S. Falke, "Earth Observations Enhance Fire and Smoke Decision Support Systems in the Eastern United States," EastFire Conference Article of Selected Papers, *EOM*, August, 2005.

### **CONFERENCE/WORKSHOP PRESENTATIONS AND POSTERS (SELECTED)**

Ambrose, S., “Extension of NASA’s Science and Technology Results, Earth Observations for Decision Support,” *Geo-information for Disaster Management* (Gi4DM), Delft, Netherlands, March, 2005.

Ambrose, S., and S. Habib, “Earth Observations Applied to Decision Support,” *IGARSS 2005*, S. Korea, July 2005.

The Disaster Management program also participated actively in the following workshops, conferences, and symposia: IGARSS, ISRSE, SPIE, SENH Workshop, Disasters Roundtable, UNOOSA Disaster Management meeting (Munich), NRC Transportation Review Board Meeting (Washington, DC, January 2005), TIGER Workshop (Africa), and Gi4DM.

### **CONTACT INFORMATION**

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## NASA Science Mission Directorate - Applied Sciences Program

### *Ecological Forecasting – Fiscal Year 2005 Annual Report* \*



#### SUMMARY

The Ecological Forecasting Program was very active in FY 2005. The President of Panama inaugurated the primary node for SERVIR, which is the program's signature decision support system to which it extends NASA Earth science research results. The program completed an evaluation report for the *Vista Decision Support System* and an evaluation report for the *Terrestrial Observation and Prediction System (TOPS)*. The program convened or participated in four workshops.

#### MAJOR ACCOMPLISHMENTS

##### ***Regional Visualization and Monitoring System (SERVIR)***

In February 2005, the President of Panama inaugurated the SERVIR primary node in the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) facility in the City of Knowledge, Republic of Panama. SERVIR supports generation of operational decision support products, including those for fires, red tides (aka, harmful algal blooms), short-term numerical weather forecasts (utilizing the Weather Research and Forecast model (WRF)), hurricane tracking, and rainfall. At the end of FY05 (and continuing into FY06), the SERVIR leadership began drafting a SERVIR Project Plan and a SERVIR Verification, Validation and Benchmark Report. The CATHALAC Director Emilio Sempris serves as a reviewer for the IPCC Fourth Assessment Report (Working Group II on Vulnerability and Adaptation). <http://servir.nsstc.nasa.gov/home.html>

*Note: Following the October eruption of El Salvador's Santa Ana volcano and October arrivals of Hurricanes Stan and Wilma, the program's SERVIR team was especially active and tirelessly dedicated to provide Central American emergency managers with land cover and flooding information to support their recovery efforts.*

##### ***REASoN: NatureServe Vista Decision Support System Supported U.S. Forest Service Forest Planning***

The NatureServe *Vista* decision support tool is designed to help planners, conservation groups, and local communities to better integrate biodiversity information into their land-use and conservation planning processes. NASA, through the REASoN CAN, supports NatureServe's integration of NASA Earth science research results into *Vista*, thereby extending those products broadly. The U.S. Forest Service (USFS) Bridger-Teton National Forest (BTNF) is a partner for this REASoN project.

In FY05, NatureServe released *Vista* Version 1.0, and BTNF subsequently installed it. NatureServe conducted a scoping workshop with BTNF, resulting in a crosswalk of forest planning requirements to current *Vista* capabilities and prioritization of new capabilities for *Vista* version 2.0. In September, NatureServe completed *Vista* 1.3 (beta version) and initiated prototyping work for functions that will calculate indices of landscape integrity and integration of aquatic biodiversity components for *Vista* version 2.0.

The project team also completed an evaluation report of *Vista* in June 2005 and established a project collaboration website on the USGS National Biological Information Infrastructure (NBII) website to

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\* The FY05-09 Ecological Forecasting Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

facilitate discussions and review of documents. The team conducted three methodology prototyping workshops and one additional workshop with the USFS research officer in charge of ecological management software to determine potential linkages with *Vista*. <http://www.nbii.gov>

### ***Terrestrial Observation and Prediction System (TOPS)***

The TOPS team continued to build its partnership with the U.S. National Park Service (NPS), creating a suite of prototype data products for use by NPS staff in Yosemite National Park. The team completed an Evaluation Report and developed a project plan for its work with NPS. (TOPS is a modeling software system that brings together technologies in information technology, weather/climate forecasting, ecosystem modeling, and satellite remote sensing to enhance management decisions.)

In FY05, TOPS distributed an average of over 210 GB of data each month, reaching as many as 21 different users in any given month. Over the course of the year, the time necessary to fulfill a request decreased from an average of 14 days to just 3-5 days. The team made significant improvements to the TOPS Planner. Improvements included integration with another TOPS tool to provide easier incorporation of MODIS datasets, combination of *Terra* and *Aqua* MODIS datasets to provide the least cloudy data for a specific region, and improved performance. Additional improvements to TOPS included a database system redesign to provide better access to a larger subset of metadata and improve database scalability; automation of the climate gridding subsystem and addition of new data sources; improvement in the DAAC interfaces; and completion of a prototype system to use direct broadcast data from *Terra* and *Aqua*.

### ***NASA-NGO Working Group Project Supporting Biodiversity Indicators***

In FY05, this Ecological Forecasting group worked to develop a Sourcebook for Remote Sensing for Biodiversity Indicators. The final version of the Sourcebook will be published by the United Nations Environment Programme (UNEP) and the Secretariat of the United Nations Convention on Biological Diversity (CBD). (Note: This work responds to biodiversity tasks in the Group on Earth Observation (GEO) 2006 work plan.)

Over the past year, the group has provided direct support to the CBD Secretariat for a variety of issues, including: participation at the *Tenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice* in Bangkok, Thailand; participation in the *Ad Hoc Open-ended Working Group on the Review of Implementation of the Convention* in Montreal, Canada; and, review and commentary on the upcoming *Global Biodiversity Outlook*.

### ***Protected Area Archive***

The Ecological Forecasting program (through JPL) completed and launched Version 1.0 of the Protected Area Archive (PAA) Viewer/Toolkit at the November 2004 World Conservation Union (IUCN) World Conservation Congress in Bangkok, Thailand. In July 2005, the World Bank Development Grant Facility provided funding for a pilot of Version 2.0, and an Indian conservation nongovernmental organization began development. The project team also secured funding for the post-pilot phase, and the team has created PAA collections for more than a dozen countries, including all the countries in Central America.

The project team received funding from The Nature Conservancy and the U.S. Department of State to enhance the Archive's "Collection Generator." With the State Department funding, the team will add the ability to utilize IKONOS imagery and to generate a collection of tsunami images, enabling an enhanced response to future disasters. The USGS EROS Data Center is reviewing the PAA for incorporation into its data services offerings.

### ***Congo Basin Forest Monitoring for USAID's Central African Regional Program for the Environment (CARPE)***

The Ecological Forecasting team played a key role in producing an assessment of the forests of the Congo Basin. Project partners at the University of Maryland chaired the assessment's editorial board, contributed material, and supported the logistics to ensure the report was ready for the *Second Summit on Forests for Heads of State in Central Africa* in February 2005. MODIS data at 250-meter spatial resolution provided the basis for classifying the Congo Basin into forest, rural complex, wooded savanna, grassland, bare ground, and water categories.

### **ADDITIONAL ACTIVITIES**

The Ecological Forecasting program element convened or participated in four workshops and major meetings in FY05:

- March 2005. *Coordinating Approaches for Utilizing Remote Sensing-Earth Observation (RS/EO) Data to Monitor and Report Landscape Dynamics in and Around Protected Areas*. NASA co-sponsored the workshop with the U.S. National Park Service, Parks Canada Agency, Canadian Space Agency, and Canada Centre for Remote Sensing.
- March/April 2005. *Ecological Modeling for NASA Applied Sciences*.
- May 2005. *IEOS Public Engagement Workshop*.
- August 2005. *Biodiversity and Ecological Forecasting Team Meeting*.

### **SOLICITATIONS**

#### ***Decisions CAN***

The Ecological Forecasting Program received 45 Step-1 proposals in the Decisions CAN and encouraged 28 to submit full proposals. In Step-2, the Ecological Forecasting program received 29 full proposals. Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected two Ecological Forecasting proposals for awards:

Global Fire Information for Resource Management: Transitioning from a Research to an Operational System with an Emphasis on Protected Areas  
*PI: Diane Davies, University of Maryland-College Park*

Integrating Earth Science Enterprise Results into Protected Area Decision Support for the Albertine Rift  
*PI: Nadine Laporte, Woods Hole Research Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including two projects for the Ecological Forecasting portfolio (the first is in conjunction with the Coastal Management program and the second with the Invasive Species program):

Predicting Right Whale Distributions from Space: An Operational System for Marine Ecosystem Modeling  
*PI: Andrew Pershing, Cornell University*

Integration of a Large-area Invasive Spread Network (LISN) into the NISFS for Ecological Forecasting  
*PI: Robert Crabtree, Yellowstone Ecological Research Center*

### **ROSES 2005 – Section A.24**

For the Applied Sciences portion of the ROSES 2005 NRA, the Ecological Forecasting program element received 14 Step-1 proposals and encouraged 9 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

### **PUBLICATIONS (SELECTED)**

Jolly, W.M., R. Nemani, and S. Running, “A generalized, bioclimatic index to predict foliar phenology in response to climate,” *Global Change Biology*, vol. 11, pp. 619-632, 2005.

Melton, F., B. Lobitz, W. Turner, E. Sheffner, and J. Haynes, “Ecological modeling for applied science,” *EOS Transactions*, 86(35):319, 2005.

Steele, B., S. Reddy, and R. Nemani, “A regression strategy for analyzing environmental data generated by spatio-temporal processes,” *Ecological Modeling*, 181: 93-108, 2005.

Steininger, M., H. Strand, and E. Fosnight, “Remote Sensing and the Monitoring of Trends in the Extent of Selected Biomes, Ecosystems, and Habitats,” in *Working Together for Biodiversity: Regional and International Initiatives Contributing to Achieving and Measuring Progress Towards the 2010 Target*, CBD Technical Series No. 17, 2005.

Turner, W. and F. Melton, “Ecological Models and Satellite Imagery,” *ESA Bulletin*, 86(4):326-330, 2005.

White, M.A., F. Hoffman, W. Hargrove, and R. Nemani, “A global framework for monitoring phenological responses to climate change,” *Geophysical Research Letters*, Vol. 32, LXXXXX, doi:10.1029/2004GL021961, 2005.

Zhou, M., F. Heinsch, R. Nemani, and S. Running, “Improvements of MODIS gross and net primary production products and results from first 3-years,” *Remote Sensing of Environment*, 95 (2005) 164176.

### **CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)**

Abrams, M, and GN Geller 2005. Increasing Access and Usability of Remote Sensing Data: The Protected Area Archive Tool Applied to UNESCO Heritage Conservation Sites. Paper presented at the *31st International Symposium on Remote Sensing of Environment*, 20-24 June, St Petersburg, Russia.

Crist, P 2005. Wildlife Conservation Planning at Differing Scales. Paper presented at the *Annual Meeting of the American Planning Association*, 19-23 March, San Francisco, CA.

Crist, P 2005. Software Tools For Mitigating Conservation Conflicts. Paper presented at the *Annual Meeting of the U.S. Institute for Environmental Conflict Resolution*, 24-26 May, Tucson, AZ.

Geller, GN 2005. Monitoring and managing with the NASA Protected Area Archive. Paper presented at the *19<sup>th</sup> Annual Meeting of the Society for Conservation Biology*, 15-19 July, 2005, Brasilia, Brazil.

Golden, K., Pang, W., “Dynamic Domains in Data Production Planning,” *Proceedings of the International Joint Conferences on Artificial Intelligence*, 31 July-5 August, 2005, Edinburgh, Scotland.

Melton, F., Nemani, R., Golden, K., Votava, P., Michaelis, A., White, M., Glymour, C., Myneni, R., Running, S., Coughlan, J., “Biospheric monitoring and ecological modeling for decision support,” *NASA Ecological Modeling Workshop Proceedings*, 29 March-1 April, 2005, Pacific Grove, CA.

Steininger, M and the NASA-NGO Group 2005. Remote Sensing and the Convention on Biological Diversity: Potential for integration into regular, global assessments. Paper presented at the *19<sup>th</sup> Annual Meeting of the Society for Conservation Biology*, 15-19 July, 2005, Brasilia, Brazil.

### **SERVIR-SPECIFIC PRESENTATIONS (SELECTED)**

The Mesoamerican Visualization and Monitoring System: Coordinated Enhanced Observing Period (CEOP)/Integrated Global Water Cycle Observations (IGWCO) Joint Meeting. Tokyo, Japan. February 28th - March 4th, 2005.

Regional Visualization and Monitoring System (SERVIR) for Mesoamerica: A XXI Century Geospatial and Satellite Tool for Transboundary Watershed Management. Organization of American States (OAS) International Conference on Transboundary Watershed Management. Lima, Perú, May 2-5, 2005

SERVIR: A Model for GEOSS Implementation in the Americas. Earth Observation Partnership of the Americas (EOPA), Satellite Data Users Workshop. Buenos Aires, Argentina. June 2-3, 2005.

The Mesoamerican Visualization and Monitoring System: Regional Caribbean Symposium on Information Sharing In Climate Change and Development Issues. Belmopan, Belize. September 12-13, 2005.

### **CONTACT INFORMATION**

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## NASA Science Mission Directorate - Applied Sciences Program

### *Energy Management – Fiscal Year 2005 Annual Report* \*



#### SUMMARY

The Energy Management program element focuses on extending NASA Earth science research results to improve decisions and assessments for energy production and energy efficiency. In FY05, the program made considerable progress on many elements of the Prediction of Worldwide Energy Resource (POWER) project and other projects.

#### MAJOR ACCOMPLISHMENTS

##### ***Prediction of Worldwide Energy Resource Project (POWER)***

The POWER project seeks to improve the Nation's public and private capability for integrating NASA solar energy and global weather products into energy production and energy efficiency systems. POWER consists of five interrelated components (Energy Production Solar Incidence Products, Energy Efficiency Environment Buildings, Energy Production/Efficiency Short-term/Mid-term Prototype Development, Energy Efficiency Energy Load Forecasting, and Energy Production Biomass Products). POWER serves multiple decision support systems (RETScreen, Hybrid Optimization Model for Electric Renewables-HOMER, Solar Sizer, and MiniCAM) and the five interrelated components use a variety of NASA products (Clouds and the Earth's Radiant Energy System-CERES, Earth Radiation Budget Energy-ERBE, International Satellite Cloud Climatology Project-ISCCP, Surface meteorology and Solar Energy-SSE, Surface Radiation Budget-SRB, GEOS, and FLASHFlux) to enhance the capability of decision support systems.

In FY05, the POWER project team completed SSE release 5 and 5.1 with a 1x1° grid. The project team also processed a multi-year dataset for the National Solar Radiation Data Base (NSRDB) maintained by the DOE National Renewable Energy Laboratory (NREL). The project team delivered a preliminary buildings prototype to members of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and it developed an agricultural/biomass prototype.

The POWER project also incorporated NASA-derived information into RETScreen, which is a decision support tool developed by the Canadian Meteorological Service (CANMET) Energy Diversification Research Laboratory (CEDRL) and used for the feasibility study of renewable energy technologies (RETs) that affect solar energy, wind energy, and geothermal energy systems. NASA and CEDRL have developed a direct link to the SSE website to provide environmental parameters that improve the cost benefit analysis of these projects to international customers using RETScreen.

<http://www.etscreen.net/ang/menu.php>

##### ***International Energy Agency (IEA) Task***

Through a NASA Memorandum of Understanding with NREL, the Energy Management program pursued this activity for NASA Earth science datasets to add value to the standardization and structure (e.g., improved spatial/temporal coverage) of energy products that serve multiple countries and are easily accessible to end users. Responding to the Group on Earth Observation System of Systems (GEOSS) draft implementation plan goals for solar irradiance datasets (Implementation Plan Task Team-IPTT

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\* The FY05-09 Energy Management Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

Section 4.3), the project used a variety of NASA products (SSE, GEWEX SRB, ISCCP, CERES, and GMAO GEOS) to support the Solar Sizer and RETScreen decision support tools, the solar energy industry, the United Nations Environment Programme's Solar and Wind Energy Resource Assessment (UNEP SWERA), renewable energy system designers/planners, and renewable energy stakeholders in developing countries.

In FY05, the Energy Management's IEA project team helped develop an IEA Annex Plan to establish NASA participation in a multi-national team; this Annex Plan received approval in July 2005. The project team participated in the American Solar Energy Society and International Solar Energy Society industry conferences in August 2005. Also in 2005, the project team began collaborative task planning and activities with the German research institute Deutsches Zentrum für Luft- und Raumfahrt (DLR).

### ***Policy Models***

This project evaluates energy policy models and establishes partnerships with model developers to extend NASA measurements and assimilation products to improve assessments that support energy management and policy decisions. The Policy Models project uses NASA products (e.g., CERES, GMAO GEOS, SSE, SRB) and focuses on DOE decision tools, including National Energy Modeling System-NEMS, System for the Analysis of Global Energy Markets-SAGE, MARKet ALlocation-MARKAL, and others.

In FY05, the Policy Models project team completed an evaluation reports and developed tables of NASA satellite measurement datasets. The team formed partnerships with decision support tool owners and developed NASA prototype products. The project team also participated in workshops in December 2004 and May 2005, met with developers of the SAGE energy policy model, and completed a DEVELOP report on MiniCAM/PGCAM.

### ***GEOSS, US GEO, CCSP, CCTP Decision Tools Evaluation***

This project identifies scenario assessments and decisions facing organizations responsible for national and international policy relating to the Climate Change Science Program (CCSP), Climate Change Technology Program (CCTP), U.S. Group on Earth Observations, GEOSS, and the World Summit on Sustainable Development (WSSD). The project team is evaluating current and future NASA greenhouse gas satellite measurements, Earth System Modeling Framework, ISCCP, SRB, SSE, and CERES to support the CCSP, CCTP, U.S. GEO, and GEOSS.

In FY05, the Decision Tools Evaluation project team completed an evaluation report identifying potential partners and decision support tools, and it established partnerships with relevant decision tool owners. The project team participated in an IEA Workshop on GEOSS in December 2004. In September 2005, the project team delivered data to the DOE Pacific Northwest National Laboratory (PNNL) for MiniCAM CCTP simulations. The project team also coordinated CCTP measurements and monitoring working group activities in support of the development of the CCTP Strategic Plan.

## **SOLICITATIONS**

### ***Decisions CAN***

The Energy Management Program received 5 Step-1 proposals in the Decisions CAN and encouraged 4 to submit full proposals. In Step-2, the Energy Management program received 2 full proposals. Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected a Water Management proposal that also had applicability in the Energy Management program area:

Improving Water Resources Management in the Western U.S. through Use of Remote Sensing Data and Seasonal Climate Forecasts

*PI: Dennis Lettenmaier, University of Washington-Seattle*

### **ROSES 2005 – Section A.24**

For the Applied Sciences portion of the ROSES 2005 NRA, the Energy Management program received 3 Step-1 proposals and encouraged 2 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

### **PUBLICATIONS & CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)**

Chandler, William S., C.H. Whitlock, P.W. Stackhouse, Jr., 2005: “Determining Wind Resources as a Function of Surface Roughness and Height from NASA Global Assimilation Analysis.” Proceedings of the *International Solar Energy Society 2005 Solar World Congress*, Orlando, Florida.

Whitlock, Charles H., W.S. Chandler, J.M. Hoell, T. Zhang, P.W. Stackhouse, Jr., 2005: “Parameters for Designing Back-Up Equipment for Solar Energy Systems.” Proceedings of the *International Solar Energy Society 2005 Solar World Congress*, Orlando, Florida.

Wilcox, Steve, R. Perez, R. George, W. Marion, D. Meyers, D. Renne, A. DeGaetano, C. Gueymard, F. Vignola, P.W. Stackhouse, Jr., 2005: “Progress on an Updated National Solar Radiation Data Base for the United States.” Proceedings of the *International Solar Energy Society 2005 Solar World Congress*, Orlando, Florida.

Hoell, James M., Paul W. Stackhouse, Jr., William S. Chandler, Charles H. Whitlock, and Taiping Zhang, 2004: “Satellite Inferred Meteorology for Agroclimatology: Comparisons of Ground Observations and Satellite Inferred Parameters.” *2004 joint ASA-CSSA-SSSA International Annual Meetings*, Oct 31 - Nov 4, 2004, Seattle, Washington.

Stackhouse, P.W., Jr., R. Birk, J. Kaye, C.H. Whitlock and W.S. Chandler, 2004: “Contributions to Solar Energy Resource Information from NASA Satellites and Modeling.” Invited presentation at *Renewable Energy Modeling Series - Modeling Solar Energy Use*, December 6, 2004, Washington, DC.

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# NASA Science Mission Directorate - Applied Sciences Program

*Homeland Security – Fiscal Year 2005 Annual Report* \*



## SUMMARY

In FY05, the Homeland Security program element focused on air transport and dispersion. The program participated in the Office of Federal Coordinator for Meteorology's efforts to pursue activities identified in the report *Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling*.

In FY06, the Homeland Security program will focus on extending NASA Earth observations to enhance air plume transport. The Homeland Security team will also work with Lawrence Livermore National Laboratory (LLNL) to improve air transport and dispersion with surface roughness parameters.

## MAJOR ACCOMPLISHMENTS

### *Interagency Modeling and Atmospheric Assessment Center (IMAAC) Project*

In FY05 the Homeland Security team initiated a joint project with LLNL's National Atmospheric Release Advisory Center (NARAC), which provides data to IMAAC. The IMAAC will be a single source of federal hazards predictions during the response and recovery phases of "incidents of national significance." The Homeland Security team targeted improvements in key parameters in NARAC's atmospheric transmission and dispersion (ATD) modeling. An initial evaluation of the NARAC decision support tool identified aerodynamic surface roughness ( $z_0$ ) as a high priority for model performance improvement. <http://narac.llnl.gov/>

The NASA team worked to prototype initial 1-km  $z_0$  products developed from MODIS leaf area index (LAI) data over a study area in Oklahoma City associated with a 2003 release experiment. The team developed a prototype with an SRTM-derived surface height map to aid in the conversion of MODIS LAI to surface roughness. Team members began producing an ASTER classification of the Oklahoma City area to test the improvements gained by modeling  $z_0$  at a higher resolution in the urban areas.

## SOLICITATIONS

### *Decisions CAN*

The Homeland Security Program received 15 Step-1 proposals in the Decisions CAN and encouraged 7 to submit full proposals. In Step-2, the Homeland Security program received 7 full proposals.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected the following Homeland Security proposals for a single, combined project:

Improved Meteorological Input for Atmospheric Release Decision Support Systems

*PI: Thomas Warner, National Center for Atmospheric Research*

An Integrated LES Modeling System for Atmospheric Dispersion of Toxic Agents: Homeland Security Applications

*PI: Udaysankar Nair, University of Alabama–Huntsville*

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\* The FY05-09 Homeland Security Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Homeland Security portfolio:

Integration of Earth Science Results with Pest Forecasting and Risk Management Decisions  
*PI: George May, Institute for Technology Development*

***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Homeland Security program received one Step-1 proposals and encouraged none to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

**PUBLICATIONS (SELECTED)**

*OFCM Federal Research and Development Needs and Priorities for Atmospheric Transport and Diffusion Modeling*, February 2005, NASA co-author.

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# NASA Science Mission Directorate - Applied Sciences Program

## *Invasive Species – Fiscal Year 2005 Annual Report \**



### SUMMARY

The Invasive Species program element works with the U.S. Geological Survey (USGS) to enhance the capabilities of the Invasive Species Forecasting System (ISFS). USGS (through the National Institute for Invasive Species Science (NISS) in Fort Collins, Colorado) is a primary respondent to invasive species among the federal agencies. In 2005, the National Invasive Species Council (NISC) invited NASA to join the Council in recognition of the collaboration between NASA and USGS on the ISFS. The NISC is an interagency group formed by Presidential Directive in 1999 and provides direction to the NISS. The contributions of NASA's Applied Sciences Program to the ISFS are the primary activity within the Invasive Species program element.

In FY05, the NASA Invasive Species team and USGS completed a benchmark report describing the impact of NASA Earth science observations and modeling capability on the ISFS. USGS plans for the operational transfer of the NASA ISFS enhancements to USGS, which should be completed in 2007. Through one on-going project and two projects added in 2005, the Invasive Species team plans to work more with the National Park Service (NPS) in the ISFS approach to extend capabilities from NASA observations and models.

### MAJOR ACCOMPLISHMENTS

#### *Systems Integration and Visualization of Yellowstone*

In FY05, the project team validated use of a new MODIS index of vegetation phenology and collected a detailed field validation data set (>17,000 point measurements). The project team developed a fluid dynamic model of wind fields of large landscapes, collected an extensive field validation data set based on custom-designed logging anemometers (>1500 logger days), and validated the model against the data set. The project team continued development of a snowpack simulation model and collected an extensive field validation data set to support this (>3000 cores). For these models, the project team delivered custom queries and developed a Yellowstone National Park-specific application of a generic algorithm for modeling species dispersal. The project team also demonstrated visualization products to the NPS interpretation staff.

In FY06, this project will deploy interactive visualization products in Yellowstone National Park visitor education centers. Team members will publish a series of journal papers on snowpack modeling, remote sensing, integration through visualization, and product impacts.

#### *Invasive Species Forecasting System (ISFS)*

In FY05, the project team deployed the ISFS Release 2 at USGS and NASA facilities and assisted in the compilation of the FY05 Benchmark report. The team also established the NASA/USGS ISFS Operational Transfer "Tiger Team" Committee and submitted an ISFS Operational Transfer Plan, and it developed an ISFS Client Interview plan and conducted interview sessions. The project team produced comprehensive MODIS Value Add Vegetation Index Summaries and related datasets and integrated these

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\* The FY05-09 Invasive Species Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

into the USGS/ISDS element of the ISFS. In FY06, the project team will deliver ISFS Releases 3 and 4 and integrate NPS and Yellowstone Environmental Research Center projects into ISFS activities.

### ***Value Added Products from Vegetation and Precipitation Time-Series Data Sets in Support of Invasive Species Prediction***

In FY05, the project team completed the first “National Tamarisk Habitat Suitability Map,” which is a tool to help land managers predict the extension of tamarisk in the U.S. The project team also derived an ISFS MODIS phenology “National Data Layer,” collected field and high-resolution data over intensive tamarisk study areas, and initiated research on agent-based modeling. In FY06, the project team will help develop a high-resolution probability/habitat map of tamarisk at four intensive study sites and will further develop the agent-based modeling.

## **SOLICITATIONS**

### ***Decisions CAN***

The Invasive Species Program received 13 Step-1 proposals in the Decisions CAN and encouraged 7 to submit full proposals. In Step-2, the Invasive Species Program received 10 full proposals, including some that overlapped significantly with the Ecological Forecasting program.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected the following Invasive Species proposal for an award:

Using the Invasive Species Forecasting System to Support National Park Service Decisions on Fire Management Activities and Invasive Plant Species Control  
*PI: Jeffrey Morisette, NASA Goddard Space Flight Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Invasive Species portfolio (in conjunction with the Ecological Forecasting program):

Integration of a Large-area Invasive Spread Network (LISN) into the NISFS for Ecological Forecasting  
*PI: Robert Crabtree, Yellowstone Ecological Research Center*

### ***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Invasive Species program element received 8 Step-1 proposals and encouraged 5 to submit full proposals. The Step-2 proposals were due in November 2005 with selections expected by April 2006.

## **PUBLICATIONS (SELECTED)**

Watson, F., *et al.* “Testing a Distributed Snowpack Simulation Model against Diverse Observations,” submitted to the *Journal of Hydrology*.

Watson, F., *et al.* “Optimal Sampling Schemes for Estimating Mean Snow Water Equivalents in Stratified Heterogeneous Landscapes,” submitted to the *Journal of Hydrology*.

Garrott, R., *et al.* “Using Snow to Map Earth's Heat from Space,” submitted to *Remote Sensing of Environment*.

Bergman, E., *et al.* “Assessment of Prey Vulnerability through Analysis of Wolf Movements and Kill Sites” *Ecological Applications*, in press.

Watson, F., *et al.* “Temporal Variability in Winter Travel Patterns of Yellowstone Bison: the Effects of Road Grooming,” submitted to *Ecological Applications*.

Morisette, J., *et al.* “A Tamarisk Habitat Niche Map for the Continental USA,” *Frontiers in Ecology and the Environment*, in press.

Stohlgren, T., *et al.* “Risk Analysis for Biological Hazards: What We Need to Know about Invasive Species,” *Risk Analysis*, in press.

Schnase, J., *et al.* “Invasive Species: An Emerging Science Application for Geospatial Information,” keynote paper, Agouris and Croitoru (eds), *Next Generation Geospatial Information*.

Cushing, J., *et al.* “Eco-informatics and natural resource management,” Raschid and Ludaescher (eds), *Proceedings of the 2<sup>nd</sup> International Workshop on Data Integration and Life Sciences*.

Morisette, J., *et al.* “A Tamarisk Habitat Suitability Map for the Continental U.S.,” *Frontiers in Ecology*, in press.

#### **CONFERENCE/WORKSHOP PRESENTATIONS (SELECTED)**

Watson, F., “Systems Integration and Visualization of Yellowstone,” *NASA Biodiversity and Ecological Forecasting Team Meeting*, Washington, DC.

Morisette, J., “Value Added Products from EOS,” *NASA Biodiversity and Ecological Forecasting Team Meeting*, Washington, DC.

Morisette, J., “The Invasive Species Forecasting System,” *Joint Workshop on Ecological Modeling for Applied Sciences*, Monterey, CA.

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# NASA Science Mission Directorate - Applied Sciences Program

## *Public Health – Fiscal Year 2005 Annual Report* \*



### SUMMARY

The Public Health program element pursued numerous activities to extend the use of NASA Earth science research results to improve the understanding of and response to factors in the environment that adversely impact the health of the American public. FY05 highlights for the Public Health program included publishing the study *Confidentiality Issues and Policies Related to the Utilization and Dissemination of Geospatial Data for Public Health Applications* with the Socioeconomic Data and Applications Center (SEDAC) of Columbia University, co-sponsoring the Ecological Modeling Conference in Monterey, California, and publishing the article “NASA Space Systems Enhance Public Health Science for Society” in *Earth Observation Magazine*.

In FY05, the Public Health application supported projects to demonstrate the capacity of Earth science research results to enhance five public health decision support tools:

- ArboNET/Plague Surveillance System (PSS);
- National Environmental Public Health Tracking Network (EPHTN) / Health and Environment Linked for Information Exchange (HELIX) Atlanta demonstration project;
- Malaria Modeling and Surveillance (MMS) / Global Situational Awareness Tool (GSAT);
- The Public Health Applications in Remote Sensing (PHAiRS) / Rapid Syndrome Validation Project (RSVP); and,
- The Secretary's Command Center (SCC), Secretary of the Department of Health and Human Services (DHHS).

### MAJOR ACCOMPLISHMENTS

#### *ArboNET/Plague Surveillance System (PSS)*

Plague prevention and response efforts were underway at regional, state and local levels through the Center for Disease Control and Prevention (CDC)-sponsored ArboNET/PSS. In FY05 the project team began using a climate-disease link tool developed by NASA-Goddard's Global Inventory Modeling and Mapping Studies (GIMMS) group to evaluate and measure improvements of the ArboNET/PSS. The GIMMS team extended the new global AVHRR-NDVI vegetation dataset at 8-km resolution and integrated it with TRMM, Landsat, SRTM, and MODIS datasets. The project team modified this application to report risk plague activity every month and to integrate data at different spatial and temporal resolutions. The project team also began work on a project website and completed an evaluation report on ArboNET/PSS in September 2005.

In FY06, the project team will develop a validation and verification report based on the relationship between climate variability and rodent population, which was a specific topic for a planned NASA-CDC partners meeting in October 2005.

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\* The FY05-09 Public Health Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

### ***EPHTN/HELIX***

As a partner with CDC's Environmental Public Health Tracking (EPHT) program in the HELIX-Atlanta project, the NASA Public Health team (especially NASA-Marshall) was active in all the project teams: Birth Defects, Air and Respiratory Health, Water, and Cancer. The partnership identified NASA Earth science observations for use in the projects, and NASA expertise in systems analysis led to the development of a quality control procedure for improving measurement of fine particulate matter.

In FY05, the Birth Defects team identified compatibility issues for the Public Health Information Network (PHIN), and it selected and enhanced the classification system for congenital heart defects appropriate for EPHT. The project team evaluated NASA satellite observation data for EPHT utility, completed an individual record review of over 3,000 heart defect cases by physicians, and developed and implemented a method for validating geocodes from the Metropolitan Atlanta Congenital Defects Program (MACDP) and Georgia's Office of Health Information and Policy (OHIP). The Cancer team completed a literature review and incorporated it into the project work plan. The team evaluated data from the Supplementary Guidance for Database Inventory Projects to identify information systems that could be employed. <http://www.cdc.gov/phin/>

The EPHTN/HELIX team published an initial benchmark report in September 2005, meeting FY05 IBPD metrics 5ESA2 and 5ESA7.

### ***Malaria Modeling and Surveillance (MMS) / Global Situational Awareness Tool (GSAT)***

In FY05, the project continued development of techniques to predict malaria cases based on meteorological and environmental parameters extracted from NASA Earth science satellite observations and climate time series. The project obtained malaria epidemiological records from the Thai Army's Pramongkul Hospital and the U.S. Armed Forces Research Institute for Medical Sciences in Thailand. The project team will use these data with remotely sensed environmental observations for training a nonparametric model for predicting malaria cases. The team is developing additional techniques to improve prediction accuracy when fewer epidemiological cases are available. In FY05, the Letter of Agreement to acquire the data (established in 2001) was extended four years to April 2009.

A FY05 report evaluating compatibility between the MMS project and the Air Force Special Operation Command's (AFSOC) GSAT concluded that the goals of the two efforts were comparable and complimentary. The report noted that enhancing the AFSOC GSAT with NASA Earth Science satellite observations and model predictive capabilities is likely to provide multiple benefits for the U.S. Department of Defense (DoD). The report stated that an enhanced GSAT capability should reduce morbidity and mortality for U.S. forces and populations in host countries, including improved utilization of larvicide, insecticide, and chemoprophylaxis. (Note: Nearly one-third of U.S. personnel involved in the 2003 Liberia operation contracted malaria). DoD plans to test the enhanced GSAT in real military exercises in 2006 and 2008, and the Public Health team has and will transmit data sets to AFSOC for use in those exercises.

### ***REASoN Project: Public Health Applications in Remote Sensing (PHAiRS) / Rapid Syndrome Validation Project (RSVP)***

In FY05, the project team regionalized the Dust Regional Atmospheric Model (DREAM) for applications in the southwestern U.S. by using dust events from 2003. The team identified and tested several remote sensing data sets for the DREAM model: MODIS land cover (MOD12), land surface temperature (MOD11/MYD11), vegetation index (MOD12), and leaf area index (MOD 15). The project team also completed the initial stages of developing GIS layers for the client mapping interface. The project completed an initial benchmark report, which stated that NASA Earth science satellite observations are

capable of improving dust episode forecasting significantly in the southwestern U.S.; the report served FY05 IBPD metrics 5ESA4 and 5ESA8. <http://www.phairs.unm.edu>

The project met with Sandia National Laboratory, Texas Tech University, and the University of Arizona to demonstrate the DREAM in a 3-D CAVE environment with and without NASA data. The project added the Texas Tech Health Sciences Center as a project partner to assist with analyzing public health data and reviewing relevant published public health data; Dr. James Speer is the primary contact.

#### ***Department of Health and Human Services' Secretary's Command Center (DHHS SCC)***

The project sought to integrate NASA Earth science research results into the DHHS SCC, which is a central node in the operational public health community with federally-mandated responsibility for public health emergency preparedness and response activities. The project expected to complete a Memorandum of Understanding (MOU) with DHHS in FY05, however the MOU was delayed due to reorganization and changes of leadership at DHHS. The Public Health team will assess this activity and possibly seek to pursue the MOU further in FY06.

### **SOLICITATIONS**

#### ***Decisions CAN***

The Public Health application received 15 Step-1 proposals in the Decisions CAN and encouraged 10 to submit full proposals. In Step-2, the Public Health program received 11 full proposals.

Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected one Public Health proposal for an award (in conjunction with the Air Quality program):

Three-Dimensional Air Quality System

*PI: Raymond Hoff, University of Maryland–Baltimore County*

The program also selected the following proposals for a single, combined project serving the Public Health, Agricultural Efficiency, and Disaster Management program elements:

Integrating NASA Earth Science Results into Malaria Early Warning Products to Enhance  
USAID Food Security and Disaster Management Decision Making

*PI: James Verdin, USGS EROS Data Center*

Enhancing the Famine Early Warning System Network Decision Support System with NASA  
Earth System Science Data and Modeling Results

*PI: Molly Elizabeth Brown, NASA Goddard Space Flight Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Public Health portfolio:

Integration of NASA Earth Science Data into Pan American Health Organization (PAHO) Health  
Analysis and Information Decision Support

*PI: Carlos Castillo-Salgado, Pan American Health Organization*

#### ***ROSES 2005 – Section A.24***

For the Applied Sciences portion of the ROSES 2005 NRA, the Public Health Program received 6 Step-1 proposals and encouraged 5 to submit full proposals. The Step-2 proposals were due in November 2005 with awards expected by April 2006.

## **PUBLICATIONS (SELECTED)**

Chandy, B., “Elemental carbon, organic carbon, EC/OC ratio and PM2.5 trends in the Southwest as revealed by a Kolmogorov-Zurbenko (KZ) filter,” Master’s thesis, University of Arizona, 2005.

Golden, Meredith L., Robert R. Downs, and Kent Davis-Packard, “Confidentiality Issues and Policies Related to the Utilization and Dissemination of Geospatial Data for Public Health Applications,” The Socioeconomic Data and Applications Center, Columbia University, March 2005, New York, NY.

Haynes, John A. and Robert Venezia, “NASA Space Systems Enhance Public Health Science for Society,” *Earth Observation Magazine*, August 2005,  
[http://www.eonline.com/EOM\\_Aug05/article.php?Article=feature02](http://www.eonline.com/EOM_Aug05/article.php?Article=feature02).

Mahler, A.B. and C. Cattrell. 2005. *DREAM Algorithm Validation: Summary of Progress and Findings*. White paper.

Melton, Forrest, Brad Lobitz, Woody Turner, Edwin Sheffner, and John Haynes, “Ecological Modeling for Applied Science,” *EOS, Transactions*, American Geophysical Union, Vol. 86, No. 35, 30 August 2005, page 319.

Morain, Stanley and William Sprigg. 2005. *Initial Benchmark Report for Public Health (February 2004 – September 2005)*. Report prepared for NASA.

Morain, S.A. and A.M. Budge. 2004. “Satellite Technology for Assessing Biological Threats and Enhancing Bio-Surveillance,” in: B. Daniels (ed.) *Proceedings, Homeland Security: Toward Converging Partnerships*. BTR 2004 Unified Science and Technology for Reducing Biological Threats and Countering Terrorism. Pages 109-117.

Pinzon, Jorge E., James M Wilson, and Compton J. Tucker (2005). “Climate-based health monitoring systems for eco-climatic conditions associated with infectious diseases” (Systèmes de surveillance de santé des maladies infectieuses, basés sur les conditions climatiques), in *Bulletin de la Societe de Pathologie Exotique*, T. 98, n° 3, 239-243. (<http://www.pathexo.fr/pages/2005n3.html>)

Pinzon, Jorge E., Molly E. Brown, and Compton J. Tucker (2005). EMD Correction of “Orbital Drift Artifacts in Satellite Data Stream,” in *Hilbert-Huang Transform and its Applications*, edited by Norden E. Huang and Samuel SP Shen. World Scientific Publishing Company (September 1, 2005). Chapter 8: 167-186.

Yin, D., S. Nickovic, B. Barbaris, B. Chandy and W. Sprigg. 2005. “Modeling Wind-blown Desert Dust in the Southwestern United States for Public Health Warning: a Case Study,” *Atmospheric Environment*, 39: 6243-6254.

## **CONFERENCE/WORKSHOP PRESENTATIONS AND POSTERS (SELECTED)**

Adeniyi, K. and W. Crosson, “Linking asthma exacerbation with exposure to particulate matter in the Atlanta metro area: Transforming environmental measurements for data linkage with HMO records,” *Environmental Public Health Tracking Network Annual Conference*, Atlanta, GA, April 20-21, 2005.

Benedict, Karl Kent, and William Hudspeth, “Technology Products of the PHAiRS REASON Project - Year 1,” presented at the 2005 *Sun-Earth System Technology Conference*, June 29, 2005. College Park, MD.

Hudspeth, William, et. al. 2005. “PHAiRS – A Public Health Decision Support System: Initial Results,” presented at the 31<sup>st</sup> *International Symposium for Remote Sensing of the Environment*. June 22, 2005. St. Petersburg, Russia.

Kiang, R. K., F. Adimi, V. Soika, and J. Nigro, “Assessing Malaria Risks in Greater Mekong Subregion based on Environmental Parameters,” *Proc. Int. Symp. On Remote Sensing of Environment*, 20-24 June 2005, St. Petersburg, Russia.

Morain, Stanley. 2005. "Dimensions of Remote Sensing for Environmental and Public Health," plenary session, *31<sup>st</sup> International Symposium for Remote Sensing of the Environment*. June 21, 2005. St. Petersburg, Russia.

Morain, Stanley A., A.M. Budge, T.K. Budge, S. Baros, K. Benedict, W. Hudspeth, C. Bales, G. Sanchez, W. Sprigg, D. Yin, B. Barbaris, B. Chandy, S. Nickovic, S. Caskey, J. Speer, and J. Bradbury. 2005. "Modeling Atmospheric Dust for a Public Health Decision Support System," *31<sup>st</sup> International Symposium for Remote Sensing of the Environment*. St. Petersburg, Russia.

Morain, Stanley and Amelia M. Budge. 2005. "Engineering Satellite Data for Environmental Health Issues," *Remote Sensing Arabia*. Riyadh, Saudi Arabia.

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## NASA Science Mission Directorate - Applied Sciences Program

### *Water Management – Fiscal Year 2005 Annual Report* \*



#### SUMMARY

In FY05 the Water Management program element largely focused on extending MODIS and Land Data Assimilation System / Land Information Systems (LDAS/LIS) products to four management decision support systems: BASINS–Better Assessment Science Integrating Point and Nonpoint Sources (U.S. EPA), RiverWare and AWARDS–Agricultural Water Resources Decision Support (Bureau of Reclamation–BoR), and Eta (NOAA).

The team accomplished a significant milestone with a benchmark report on the use of the North American Land Data Assimilation System (NLDAS) land surface states to improve the NOAA Eta model for weather forecasting. In addition, the team accomplished significant progress towards use of NASA satellite products by BoR and EPA through LIS products and accompanying land surface models (LSMs) in BASINS, RiverWare, and the AWARDS Evapotranspiration (ET)-Toolbox.

#### MAJOR ACCOMPLISHMENTS

##### ***Benchmark Report for NLDAS products in NOAA National Centers for Environmental Prediction (NCEP) Eta Mesoscale Forecasting***

The project team performed benchmarking of NLDAS land surface states and MODIS snow cover data through comparisons of a series of retrospective NOAA Eta weather model simulations. (NASA, NOAA, and a consortium of universities developed NLDAS, and its input involves products from MODIS and other satellites.) The team used LIS to generate initial states for 20 control simulations and 60 experimental simulations. The use of NLDAS initial conditions, along with use of MODIS snow cover, greatly improved surface forecasts of relative humidity and temperature. When MODIS snow cover was assimilated into NLDAS initial conditions, the Eastern U.S. bias in 2-meter temperature forecasts from baseline Eta model simulations improved by 21% versus standard NCEP simulations, and they improved by 16% over the western half of the continental United States (CONUS). Similarly, the 2-meter relative humidity forecasts improved by 78% over the eastern CONUS and by 15% over the western CONUS versus the NCEP baseline run in these same simulations. Building on the promising approach with NLDAS uncoupled initializations, the project will pursue further development before a potential consideration for operational implementation within NOAA NCEP. The Water Management program expects NOAA to eventually adopt some of the techniques and data sets utilized in this project.

##### ***BoR RiverWare & AWARDS ET Toolbox***

In collaboration with BoR, this project focused on evaluating and benchmarking NASA Earth science products for RiverWare and AWARDS ET-Toolbox decision tools; LIS water availability products and satellite MODIS snow and land cover products were of primary interest for inclusion in BoR's tools. The team also worked on integrating Earth science products in an observation-based modeling system addressing BoR regional office needs. The team evaluated retrospective studies and near real-time simulations to determine how NASA Earth science products enhanced monitoring and forecasting of water supply and extreme events. BoR team members created computer programs to incorporate and evaluate the first set of 1/8 degree NLDAS and 1-km LIS model runs, helped evaluate forcing fields used

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\* The FY05-09 Water Management Program Element Plan is available through: <http://aiwg.gsfc.nasa.gov/dss.html>

in NLDAS and LIS, and helped validate the snow water equivalent and soil temperature fields from these runs. Initial results have shown BoR decision tool enhancements through special applications of LIS ET, LIS soil moisture, LIS precipitation, MODIS-derived snowpack, and MODIS-derived land cover information.

In FY05, the team successfully developed and integrated the latest MODIS version 4 (MODIS.v4) land products for use in the LSMs in LIS, including land cover classification (MOD12), the land-water mask (MOD12), leaf area index (MOD15), land surface temperature (MOD11), and snow cover (MOD10). The project found that MODIS snow cover could identify snow in grid pixels correctly when no cloud cover was detected, which has been deemed suitable for use in several of the LSMs.

The team also used MODIS surface temperature data to update the ET transfer coefficients used by BoR in support of the AWARDS ET-Toolbox (the current transfer coefficients were out of date). This work also resulted in quality control and correction of the MODIS Land Surface Temperature Product. The project team applied data-merging techniques to LIS products in order to appropriately align different satellite datasets and parameters for use in land surface models, enabling the team to remove existing artifacts in datasets and improve use of LSMs by decision tools. The project team includes NASA, BoR, Desert Research Institute (DRI), University of Nevada, and University of Idaho, and the project study areas included the Truckee-Carson Rivers, Columbia River, and the Middle Rio Grande River Basins.

### ***EPA BASINS***

The project team evaluated NASA LIS water availability products (precipitation and ET) and MODIS Land Cover and Vegetation Index products to improve water quality modeling for BASINS. Specifically, the project focused on Hydrological Simulation Program-FORTRAN (HSPF), which is a continuous watershed model that produces a streamflow hydrograph at specific points in a drainage basin. Improvements to the predictive capability of HSPF produce more accurate streamflow in BASINS as well as identification of specific water quality parameters, such as pollutant concentrations.

The project expects that spatially-distributed precipitation product derived from LIS should produce improved forcing when compared to the gauge-only approach currently used by EPA. In addition, the project team has used LIS ET products to provide a spatially- distributed estimate that is superior to the current ET models used in HSPF. Both Landsat and MODIS data were effectively shown to model the export of nitrogen deposition in the watershed from the intensity of defoliation via environmental disturbances.

In FY05, project team members demonstrated that LIS ET provided significantly improved flow estimates for BASINS. The team also demonstrated that use of MODIS Land Cover and Vegetation Index products and Landsat data led to successful monitoring of water quality nutrients and sediments from ecosystem disturbances, such as from logging and gypsy moth defoliation.

In FY06, the project team will customize NASA products for improving BASINS water quality, and the team expects to complete an evaluation report and a benchmark report for BASINS. The project team includes NASA, EPA, Hunter College, and the University of Maryland-Center for Environmental Studies (UMCES); Mississippi State University supports the non-point source pollution work.

## ADDITIONAL ACCOMPLISHMENTS

### ***NASA Representation in UNESCO-WMO Hydrology for the Environment, Life, and Policy (HELP)***

NASA (through the Applied Sciences Program, NASA-Goddard Terrestrial Hydrology Program, and the University of Maryland Baltimore County-Goddard Earth Science and Technology Center) coordinated the North America region of the Hydrology for the Environment, Life, and Policy Program (HELP). The United Nations Educational, Scientific, and Cultural Organization's (UNESCO's) and the World Meteorological Organization (WMO) established HELP in 1999 to bring water managers, decision makers, stakeholders, scientists, and academicians together to determine needs and find solutions to water management issues through a "bottom-up" approach. NASA support has been instrumental to HELP through numerous meetings and teleconferences.

In FY05, the Water Management team worked on the "Maghreb" interagency effort (countries of Tunisia, Algeria and Morocco) to support possible water management activities through a State Department request. NASA helped coordinate an interagency study involving USGS, USDA, NOAA, and State Department to identify water management issues for State Department's Science and Technology initiative. NASA led a delegation of water resources specialists to evaluate specific water resources problems in the Maghreb region, including identification and prioritization of each country's water resource and water management needs.

## SOLICITATIONS

### ***Decisions CAN***

The Water Management Program received 36 Step-1 proposals in the Decisions CAN and encouraged 25 to submit full proposals. In Step-2, the Water Management program received 22 full proposals. Following the panel reviews and internal assessment for programmatic balance, the Applied Sciences Program selected a Water Management proposal (in conjunction with the Energy Management program):

Improving Water Resources Management in the Western U.S. through Use of Remote Sensing Data and Seasonal Climate Forecasts

*PI: Dennis Lettenmaier, University of Washington-Seattle*

The Applied Sciences Program selected the following proposals for a single, combined project serving the Water Management and Disaster Management program elements:

Use of NASA Remote Sensing Datasets in NOAA National Weather Service River Forecast Centers' Hydrologic Modeling

*PI: Ashutosh Limaye, Universities Space Research Association*

Improving NOAA/NWS River Forecast Center Decision Support with NASA Satellite and Land Information System Products

*PI: Pedro Restrepo, NOAA*

The Program also selected the following proposals for a single, combined project serving the Water Management and Disaster Management program elements:

National Drought Monitoring System for Drought Early Warning Using Hydrologic and Ecologic Observations from NASA Satellite Data

*PI: Son V. Nghiem, NASA-Jet Propulsion Laboratory*

Enhancement of the U.S. Drought Monitor by Integrating NASA Earth Science Data

*PI: James Verdin, USGS EROS Data Center*

The Applied Sciences Program later selected additional proposals for one-year awards from a Congressionally-directed augmentation, including one project for the Water Management program portfolio (in conjunction with the Disaster Management program):

Flood Inundation Enhancement for NOAA's Advanced Hydrologic Prediction Service  
*PI: G. Robert Brakenridge, Dartmouth College*

## **PUBLICATIONS AND CONFERENCE/WORKSHOP PRESENTATIONS AND POSTERS (SELECTED)**

Arsenault, K., P. Houser, S. Hunter, D. Frevert, S. Meyer, and D. Matthews, "The use of land data assimilated products to improve flood and drought risk analysis and forecasting in the Columbia River Basin," poster presented at the 85<sup>th</sup> AMS Annual Meeting, January 2005, San Diego, CA.

Arsenault, K., A. Pinheiro, R. Stodt, D. Matthews, and P. Houser, 2005. "A comparison of LDAS Land surface model evapotranspiration estimates using satellite-derived products," poster presented at the USBR-Alliance University Evapotranspiration Workshop, February 2005, Denver, CO.

Toll, D., K. Arsenault, C. Peters-Lidard, P. Houser, S. Kumar, E. Engman, J. Nigro, and J. Triggs, "NASA LIS Water Availability to Support Reclamation ET Estimation," *US Bureau of Reclamation/USDA/USGS Evapotranspiration Workshop*, March 2005, Fort Collins, CO. Technical Presentation and Technical Paper.

Toll, D., X. Zhan, and C. Peters-Lidard, "NASA Soil Moisture Observations and Modeling," *NASA-USDA FAS Project Review*, October 2004, College Park, MD, E. Sheffner Review Coordinator, Technical Presentation.

Toll, D., J. Triggs, J. Nigro, K. Arsenault, E. Engman and A. Pinheiro, 2005. "Improving Water Management Decision Support Systems Using NASA Data Products," *NASA-USDA 2<sup>nd</sup> Applications Workshop*, April 2005, New Orleans, Poster Presentation.

Toll, D., R. Eckman, and S. Habib, 2005. "NASA Research and Applications for Renewable Hydroelectric Energy Use," *Renewable Energy Modeling Series-Modeling Hydroelectric Energy Use*, NREL Workshop, May 2005, Washington, DC.

Triggs, J., HELP session coordinator, 2005. "Managing Watersheds for Human and Natural Impacts: Engineering, Ecological, and Economic Challenges," *ASCE-EWRI Watershed Management 2005 Conference*, July 2005, Williamsburg, VA.

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